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TABLE OF CONTENTS.

	Page.
LEADING ARTICLES:	
The Old Essex-Merrimac Chain Suspension Bridge at Newburyport, Mass., and Tests of Its Wrought-Iron Links After 100 years' Service (illustrated); A. P. Mills	129
A New Bolt Socket for Concrete Construction (illustrated)	132
The Economical Design of a Reinforced-Concrete Floor Panel (illustrated); J. Norman Jensen	133
Anticorrosive and Antifouling Paints for Ships' Bottoms; Experience of the U. S. Navy (illustrated); Henry Williams	136
Col. Jackson Ellsworth Sickels (portrait)	138
A Proposed Modification in Railway Freight Yard Design (illustrated)	139
The Engineering and Technical Societies of the United States and Canada	139
Progress on the Raising of the "Maine" (illustrated)	142
Railway Tests of Air-Brakes. 1878-1909	143
Notes from the Bureau of Buildings, New York City (Manhattan), 1910 (illustrated)	144
Statistics of Railways in the United States for the Year Ending June 30, 1910	153
Speed Regulation in the Electric Power Plants of Sioux Falls, S. Dak. (illustrated); H. B. McDermid	154
Some Comparative Corrosion Tests of Steels and Irons (illustrated)	156
Ferrite Cements and Ferro-Portlands; Edwin C. Eckel	157
Notes from Engineering Schools	158
Superelevation for Curves on Macadam Roads (illustrated)	159
EDITORIAL	147
Rusting, Rust-Prevention and Paint—Amateur Experts in the Field of Railway Safety Appliances—Concerning the Exploiting of Engineering Graduates.	
Changes in the Organization of the National Engineering Societies	148
LETTERS TO THE EDITOR	149
The Expansion and Contraction of Concrete During Setting, with Especial Reference to Cinder Concrete; A. Marston—A Proposal to Give Up the Street Surface to Railway Use; Charles S. Wray—On Specifications for Steel Bars for Concrete Reinforcement; T. L. Condron, M. Am. Soc. C. E.—Vitrified Clay Pipe for Pipe Lines in Alkali Soil; Benjamin Brooks—The Bridgeport Wreck and Automatic Stops—The Relation Between the Fire Loss and Politics in Municipal Fire Departments; Harry W. Bringhurst—Prevention of the Electrolytic Destruction of Reinforced Concrete; B. G. Worth and H. P. Brown—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK	159
PERSONALS	160
ENGINEERING SOCIETIES	160

The Old Essex-Merrimac Chain Suspension Bridge at Newburyport, Mass., and Tests of Its Wrought-Iron Links After 100 Years' Service.[1]

By A. P. MILLS.[2]

In November of the year 1810 the Essex-Merrimac chain suspension bridge, as shown by the views, Figs. 1 and 2, was thrown open to the public. In the late summer of 1909 the bridge was closed to travel on the assumption that it had become unsafe after a century of continuous use. These two simple statements tell a story of early American achievement in bridge engineering hardly paralleled in our history.

In order to show the place held by the Essex-Merrimac Bridge in the history of the suspension bridges of the world, an attempt will be made to present in very brief form an account of all the suspension bridges of which we have any record whose building antedated the time of construction of the Essex-Merrimac Bridge. In point of length of service it is certain that no suspension bridge in existence can rank with the old chain bridge at Newburyport.

ABORIGINAL BRIDGES.—Although the earliest application by man of the suspension principle for bridges probably far antedates extant records of the mechanic arts of the ancients, we are compelled to come down to comparatively modern times for authentic accounts of the earliest known suspension bridges.

De Ulloa,[3] writing in 1752, describes suspension bridges known in South America before its discovery by Europeans. These primitive bridges were made by twisting together creepers to form large cables which spanned rivers or valleys. Four such cables bound together and covered with reeds constituted the footway while two others served as hand rails. Another type of South American bridge described by De Ulloa, called the "tarabita," was capable of transporting beasts of burden as well as people. This consisted simply of one large cable six or eight inches in diameter formed of twisted strands of creepers or oxhide thongs. One shore end of this rope is made fast to a post, the other end being led round a drum used to put tension upon the rope. A leathern hammock suspended from the cable by a loop or clue at either end served for the transporting of both men and animals. A small rope affixed to this hammock and leading to either shore was used to draw passengers across. Some times two tarabitas were built inclining in opposite directions, each used for transportation in one direction only.

Thomas Pope[4] quotes Turner's history of his embassy to "Tibet" in giving accounts of very ancient suspension bridges in Asia. A bridge at Bootan built for the accommodation of single passengers communicated between two mountains. It consisted of two ropes made of twisted creepers stretched parallel to one another and encircled with a hoop. The traveler sits in the hoop between the ropes and drags himself along by hand hold on the ropes.

Another type of bridge described by Turner is perhaps the earliest known chain suspension bridge. This bridge, historically known as the "Bridge of Chuka," crossed the Tehentchieu River in Tibet with a span of about 140 ft. It consists of a roadway carried by five chains covered with bamboo mats, while two more chains carry bamboo railings on either side for the security of travelers. The antiquity of this bridge was so great that the natives had no knowledge of its building and attributed it to fabulous origin.

Another chain bridge found at Bootan by Turner consisted of two chains, 4 ft. apart, between which a plank walk 8 ins. wide for foot passengers was suspended by roots and creepers which latter had to be replaced annually. This bridge had a span of 70 ft.

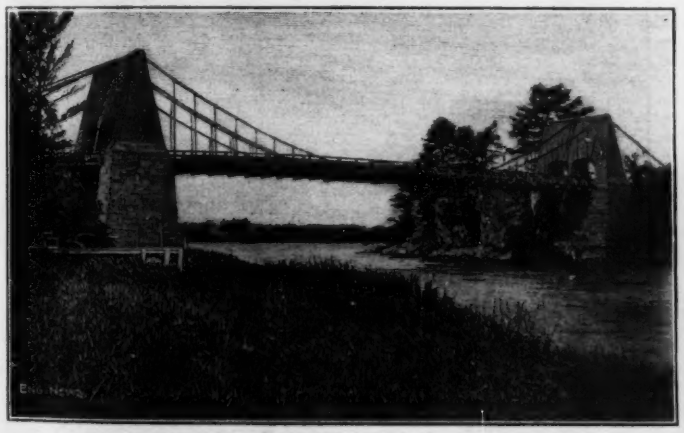
EUROPEAN BRIDGES.—In Europe rope bridges were once much used in time of war; one across the Clain[5] was used in the siege of Poictiers during the reign of Charles IX of France. Henry, Prince of Orange, used similar bridges in campaigns against Ghent and Bruges in 1631; they were used again in Italy in 1742 and later in 1792.

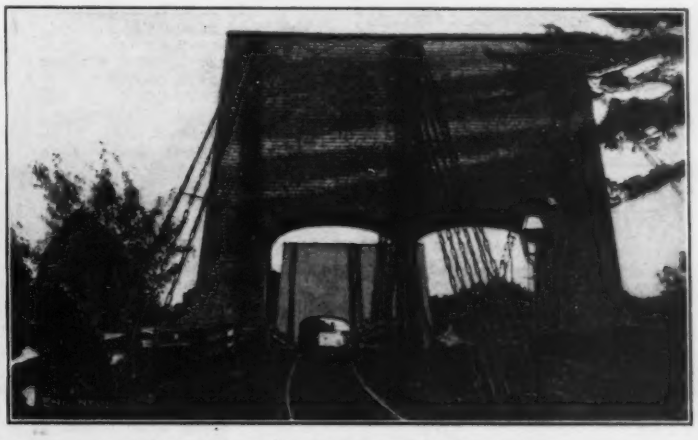
M. Navier[6] speaks of a chain stretched across between two rocks that command the town of Moustiers in the Département des Basses Alpes. It is 636 ft. long, made of rods 2 ft. 1½ ins. long and ¾ in. in diameter hooked into one another. The date of its erection is supposed to be in the thirteenth century. It appears, however, not to have been used as a bridge, but rather as an offering to the Virgin to obtain protection for the town. It is interesting to note that the iron is said not to have been injured by rust.

We have no accounts of the existence of iron suspension bridges in Europe before the middle of the eighteenth century. The first European chain bridge appears to have been that built across the Tees in England, two miles above Middletown[7], about the year 1741.[8] The Tees bridge was a footbridge, built for the convenience of miners in the district. Its span was 70 ft., width a little more than 2 ft., and its height above the chasm was 60 ft. Two iron chains carried the planked footway and a handrail was provided on one side.

The construction of iron bridges seems not to have again engaged the attention of English engineers until the year 1814.

FINLEY'S BRIDGES.—The construction of iron suspension bridges in America was inaugurated in 1796 by Mr. James Finley, of Fayette County, Pennsylvania, by the building of a chain suspension bridge, 70 ft. long, 12½ ft. wide, across Jacob's Creek, on the road between Union Town and Greenburg. This bridge was warranted for fifty years, except for the woodwork. Drewry[9] asserts that Finley patented his chain bridge in 1801, but reference to the records of the U. S. Patent Office proves





FIGS. 1 AND 2. TWO VIEWS OF THE NEWBURYPORT CHAIN SUSPENSION BRIDGE BEFORE ITS DEMOLITION.
(Built 1810, closed 1909.)

[1] Condensed fr... ...rticle in "The Cornell Civil Engineer" of April, 19...

[2] Assistant Professor of Materials, Cornell University, Ithaca, N. Y.

[3] Voyage Historique de l'Amerique Meridionale, 1752.

[4] Treatise on Bridge Architecture, 1811.

[5] Charles Stewart Drewry, "A Memoir on Suspension Bridges." 1832.

[6] "Memoire sur les Ponts Suspendus," 1830.

[7] Hutchinson's "Antiquities of Durham." 1794.

[8] According to Robert Stevenson, Edin. Phil. Journal. No. 10.

[9] "A Memoir on Suspension Bridges." 1832.

the error of this statement. A patent was granted to Finley in 1808 for a supposedly new type of chain bridge, described as follows in the patent:[10]

The bridge is solely supported by two iron chains, one on each side, the ends being well secured in the ground, and the chains raised over piers of a sufficient height erected on the abutments at each side, extended so slack as to describe a curve, so that the two middle joists of the lower tier may rest on the chains. The other joists of the same tier are attached to the chains by iron pendents of different lengths, so as to form a level of the whole. In order that the chain may support as much weight as it can bear, when hung with the weight attached to the end of it, the piers must be so high as to give the chain a sinking or curve of the one full seventh of the span. The ends of the chains must descend from the tops of the piers with the same inclination that they take inward, until each end reaches the bottom of a digging, large enough to contain stones and other materials sufficient to counterbalance the weight of the bridge, and what may chance to be thereon. The chains, of only one to a side, must be made with four branches at each end, to be let down through as many stones, and to be bolted below. These stones are laid flat on the bottom of the digging; other flat stones may be placed thereon, to bind and connect the whole, that they may have the same effect as a platform of one piece; four or more joists will be necessary for the upper tier to extend from end to end of the bridge—each will consist of more than one piece; the pieces had best pass each other side by side, so that the ends may rest on different joists on the lower tier. The splice will then extend from one joist to another of the lower tier, and must be bolted together by one bolt at each end of the splice. The plank flooring is laid on this tier. It will probably be found most convenient that the chains be made with links as long as the space between the joists; every other suspender must attach to a link of the chain edge upwards; perhaps this may best be done by a clevis to go through the upper link of the suspender, and embrace the link of the chain and receive a key above—the other suspender will come up through the flat links of the chain and receive a key above—the lower end of the lower link of the suspender may be made so wide as to receive the end of the lower tier of joists.

Pope[11] states that eight bridges were built on Finley's plans between 1801 and 1811.[12]

The largest, erected at the falls of the Schuylkill, is 306 ft. long, and 18 ft. wide, with one intermediate pier. It is borne by two chains, one on each side, the iron of which is 1½ in. square. There is one at Cumberland, Maryland, 130-ft. span, 15 ft. wide, supported by two chains of 1¼-in. bar; one over the Potomac above Federal City, of nearly the same dimensions as the last; one built in 1810 over the Brandywine at Wilmington, 145-ft. span, 30 ft. wide, supported by four chains of 1⅛-in. bar, two carriageways and one footpath; one at Brownsville, Fayette County, Pa., 120 ft. long, 18 ft. wide, 1¼-in. bar; one near Brownsville, 112 ft. long, 15 ft. wide, 1¼-in. bar; and one (1809) over the Neshamany in Bucks County, Pa., nearly 200-ft. span, one pier. The one at Jacob's Creek previously noted and the one over the Merrimac near Newburyport, Mass., which will later be described in detail, complete the list of chain bridges built in America before 1811. It is stated by M. Cordier[13] (1820) that since the date of Mr. Finley's patent forty bridges had been built.

Finley[14] states that, allowance being made for the extra thickness at the ends of the bars and for wastage in making, etc., a 1½-in. chain will weigh 16 lbs. per ft. and one of 1-in. bar will weigh 7⅛ lbs. per ft. About 1/13 the span will give curvature sufficient and 1/5 the weight of chains will be iron sufficient for suspenders, bolts and keys. The inventor's computations were made upon the basis of 60,000 lbs. per sq. in., which he considered "something less than the strength of iron of the lowest quality." His conclusions regarding the proper sinking of the curve, the length of suspenders, links, etc., and the angle of inclination of the shore ends of the chains were based upon experiments made with a weighted cord hung over pulleys. Discussing the shape of the links, Finley says that since the links cannot be made to fit as close and full as could be wished in order to put the bars in direct tension without bending stresses the end portion of each of the bars forming a link should be made ¼-in. larger for nine or ten inches. He considered it best not to round the inside of the links at the ends and to make each link so wide that the side of the next one can turn freely in it. This wideness must be filled up with the thickness of the end of the next link. He states that both sides of the link may be calculated to develop their full load if the end of the link contains two or three times as much metal as in any other part of the link. Finley states that, aside from the consideration paid by some to the danger of injury or loss of strength continued tension,

two other considerations must be attended to—the corrosion at least of some of the parts, and we must not expect the execution of the work as complete as the mind could conceive it. And here I would earnestly recommend all those concerned, to adopt it for a maxim, that the chains in all cases should be able to support five or six times the weight of the bridge.

The anchorage as designed by the inventor was simply a pit in the bottom of which he placed a large flat stone platform upon which he loaded rock ballast until the weight of each anchorage was 1⅛ times the weight of the entire bridge. His platform was inclined so that it stood more nearly normal to the direction of pull of the chains than would be the case if it were horizontal.

Finley appends the following table showing the strength of iron:

	Lbs. per sq. in.
Cast iron, direct tensile strength	42,000
Bar iron, direct tensile strength	49,000
Ordinary, direct tensile strength	68,000
Stirian, direct tensile strength	75,000
Best Swedish and Russian, direct tensile strength	84,000

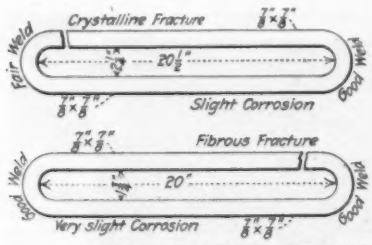


FIG. 3. SKETCH OF TEST LINKS NOS. 7 & 8.

(The dimensions vary so mewhat for the different links, but the above sketches are typical. All breaks occurred either in or near the ends.)

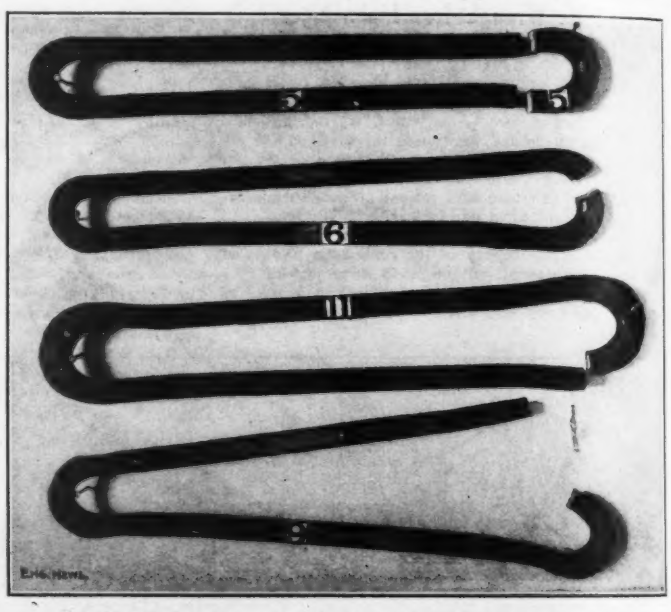


FIG. 4. FOUR OF THE TESTED LINKS, AFTER RUPTURE.

The Essex-Merrimac Bridge at Newburyport.

The building of a bridge across the Merrimac River was first proposed June 1, 1791.[15] The proposal was strenuously opposed by the town of Newburyport, but after a sharp controversy the general court granted permission to build. The opposition to the substitution of a bridge for the ferries is explained by the fact that the Merrimac turns many mills and a century ago there was more shipbuilding on its estuary than anywhere else on the continent.

The first arch bridge was opened to the public Nov. 26, 1792. It consisted of two bridges resting on Deer Island in the midst of the river. The Newburyport arch had a span of 160 ft. and the Salisbury arch 113 ft. The bridges were built under the direction of Mr. Timothy Palmer upon his timber arch principle.[16] In 1809, the Newburyport span was declared unsafe and was sold at auction, to be replaced a year later by the Finley chain bridge, which of all the chain suspension bridges, forty or more in number, built upon Mr. Finley's plans has longest remained a monument to the genius and conservatism of its designer.

This bridge is described by Pope[17] and his description is quoted by Drewry,[18] by Navier,[19] and others. It has been thought best, however, for the sake of historical accuracy to go back to the original somewhat more ample description of the bridge published in the Newburyport "Herald," Dec. 14, 1810:

The chain bridge, recently thrown over the Merrimac, three miles from this town, is now open for the accommodation of travelers. As the principles and mode of its construction are novel in this part of the country (being the first of the kind erected east of the Schuylkill), a particular description may be interesting to some readers. It consists of a single arch of 240 ft. span, and 40 ft. at its greatest elevation from the water. The abutments, 49 x 25 ft. at the base, 43 x 20 at the top, and 37 ft. high, are constructed entirely of rough and split stone, the latter of which is used in the exterior walls, each stone varying from ½ to 2½ tons in weight, and from 3 to 14 ft. in length, connected together and secured by iron bolts. The whole quantity of stone is 4,000 tons. On the abutments at each side of the river, framed piers or uprights are erected, of a sufficient height, and capped with stout timber to support the chains, from which the flooring of the bridge is supported. The chains,[20] ten in number, were passed over the caps of the uprights, and extended or slackened so as to pass under the two middle cross joists of the flooring, and to describe a sinking or curve, the entire distance of which, from a right line, is one-seventh part of the span; these are tripled where they bend over and rest on the caps; are each 516 ft. in length, and 256 ft. along the curve line between the uprights. The ends descend from the uprights (with an angle of the same inclination that the curve makes inwards), to a space below the surface of the ground, and there secured sufficiently to counterbalance the bridge and all possible weight that may be brought thereon. The whole quantity of iron used in chains, securities, etc., is 22 tons. The two middle cross joists of the flooring rest upon the chains, and other joists are attached to them in nearly a horizontal line by suspenders from the curve. On the joists the string pieces are laid lengthwise, which receive the plank. The whole flooring admits two passages, 15 ft. wide, rises 3 ft. in the center, is firmly connected and strengthened by a stout railing, and has a very light and agreeable appearance. Horses with carriages may pass upon a full trot with very little perceptible motion of the bridge. The whole weight of flooring, chains, suspenders, etc., commonly supported, does not exceed 100 tons, transient weight, the third part of which it is presumed can never be brought upon the bridge at the same time. The total cost is about $25,000. John Templeman, Esq., of the territory of Columbia, the contractor, under whose superintendence this work was constructed, and for whose unremitting attention, ingenious talents, and the many valuable improvements suggested and adopted by him in its progress; likewise to Mr. Samual Carr, of Newbury, the master carpenter, whose knowledge in bridge architecture is well known and appreciated, the public are much indebted, and we congratulate them upon the approbation of those who have viewed it since its completion. The principle upon which this work was constructed was originally invented by James Finley, of Fayette County, Pennsylvania, and patented to him in 1808; it has since been considerably improved. As its chief materials are iron and stone, the woodwork being an inconsiderable part, very light, and its mode of construction peculiar, its superiority to timber bridges is obvious, and consists in simplicity of construction, durability and ease and cheapness of repair. It is particularly adapted to the bold features of the New England States, where rivers have high, precipitous banks, rapid tides and deep waters, and where, after fair experiment, we hope to see it generally adopted.

Mr. O. B. Merrill, of Newburyport, Mass., is authority for the statement that the suspension chains for the bridge were forged on the spot and that the old smithy in which the work was done is still standing though for many years it has served as a dwelling house, into which it was converted. The blacksmithing was done partly by Mr. Hall and partly by Mr. Williams. The wood work was wholly rebuilt in 1869 under the supervision of Mr. B. F. Stanley, but the iron work remained to the end as originally put in except for occasional repairs.[21]

In 1885 and again in 1896 official inspection was made of the strength and security of the structure. The latter examination was by a special legislative committee to ascertain the ability of the bridge to carry safely the electric cars that had for some time been running over it. The conclusion was that it would stand any strain likely to be encountered under legitimate conditions.

The only disaster that ever befell the bridge was in the winter of 1827. The accident is best described by again quoting from an account published at the time in the Newburyport "Herald," Feb. 9, 1827:

On Tuesday morning last, the Essex-Merrimac bridge gave way in the center, from the parting of the chains which supported it. On the bridge at the moment, was a loaded team, drawn by six oxen and two horses, driven by two men, Messrs. Carlton and Jackman, all of whom

[10] "U. S. Patent Office Records." Also "Portfolio" for June, 1810.
[11] Treatise on Bridge Architecture. 1811.
[12] See also "Portfolio" for June, 1810.
[13] Volume II, of "l'Histoire de la Navigation Intérieure." 1820.
[14] "Portfolio" for June, 1810.
[15] History of Newbury, Joshua Coffin, 1845.
[16] Theodore Cooper in "American Railroad Bridges" gives an illustrated description of this bridge.
[17] "Treatise on Bridge Architecture," 1811. Page 171.
[18] "Memoir on Suspension Bridges."
[19] "Mémoir sur les Ponts Suspendus."
[20] Designed to sustain 500 tons, according to Pope.—A. P. M.
[21] See article by Horace C. Hovey in "Scientific American," Oct. 17, 1896.

were precipitated 40 ft. into the river beneath. The teamsters preserved themselves by means of swimming, and the support of fragments of the bridge. The cattle were all of them, except one of the horses, swept beneath the ice a few rods below and drowned.

Five of the ten chains, which supported the bridge, were snapped in different places, and now remain upholding the broken and shattered timber, altogether as sad a wreck as we ever witnessed. At the instant of the crash, the light evolved by the friction of the chains resembled the vivid streaming of a meteor.

Various causes are assigned for the accident, and none, with more probability, than the united effect of the incumbent pressure of the immense body of snow lying upon the bridge, and the frost which had contracted the particles of iron. These produced a tenseness in the chains which was incapable of resisting the additional pressure of the loaded team, and the whole gave way.

The estimated expense of repairing the breach is about $4,000, and the directors, we understand, mean to set about it immediately. It will be built up as before.

From the "Herald" of Feb. 27, 1827:

The proprietors of the Essex-Merrimac bridge, at their meeting last week, came to the conclusion to rebuild the bridge, on the former construction. One very important, if not essential improvement, however, will be introduced, which will entirely obviate the objections, light as they are, which have been made to the plan of chain bridges. The bridge will be built in two entirely distinct parts, without any connection whatever between the two, so that, on any apprehension of danger from passing with a heavy load, that part may be taken which is not laden. The bridge will be supported by two or three chains in addition to the former number.

At the time of the rebuilding of the chain bridge the

Fig. 5. Fracture Faces of Link 5, After Test.

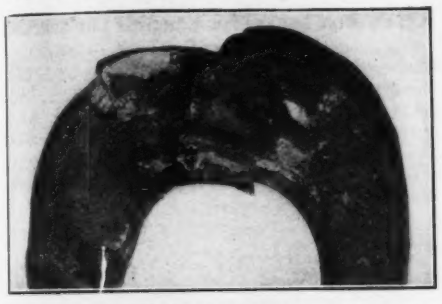


Fig. 6. Fracture of Link 4; Weld Opened and Metal Partly Torn.

directors deemed it expedient to test the quality of the broken chains by actual experiment (Newburyport "Herald," March 27, 1827):

Three links, indifferently taken from the old chains, and three new links, made from Swedish iron have been subjected to alternate bending to a certain extent until they broke. The results were as follows, viz.:

First trial, new link bent twice and broke.
Second trial, new link bent three times and broke.
Third trial, new link bent nine times and broke.
Fourth trial, old link bent twice and broke.
Fifth trial, old link bent eleven times and broke.
Sixth trial, old link bent twelve times and broke.

Three from the broken chains and two new links, were twisted by a power of from 20 to 25 tons.

First trial, a new link twisted ½ round.
Second trial, a new link twisted 1 round.
Third trial, an old link twisted ¾ round.
Fourth trial, an old link twisted 1 round.
Fifth trial, an old link twisted 1½ round.

These trials were made with the iron cold, and were perfectly satisfactory to the large number of gentlemen who saw them, among whom were some who had fears of the truth of the hypothesis of deterioration.

A small link, made when the chain bridge was erected, and from the same iron with the chains, and preserved out of use ever since was severely tried with another link exactly like it, made from a link which broke in the catastrophe. The result was strikingly in favor of the iron which had been in use.

It is impossible to tell just when in its long life the bridge was repaired. Mr. Stanley, who inspected the bridge about twenty years ago, says that the links of the anchorage were embedded in puddled clay so hermetically as to prevent corrosion, the calipers showing no sign of shrinkage. Capt. C. M. Pritchard,[22] superintendent of highways and bridges for Newburyport (1896), stated that the average annual cost of repairing the woodwork had not exceeded five dollars during the preceding ten years.

Mr. H. C. Hovey is authority for the statement that the links were made of "best Norway iron." An exhaustive search has failed to find any other reference to the source of the iron with the exception of the statement made above that the links used to repair the bridge in 1827 were of Swedish iron. There is no evidence that the links were ever painted after the completion of the bridge. A search of the itemized city reports of

[22]Engineering Record, Oct. 6, 1900.

TABLE I.—TENSILE TESTS OF ENTIRE LINKS FROM NEWBURYPORT CHAIN SUSPENSION BRIDGE AFTER 100 YEARS' SERVICE.

Link No.	Degree of corrosion.	Total cross-section (both sides), sq. ins.	Yield-point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Fracture.
1	slight	1.64	....	37,300	Fibrous.
2	slight	2.00	....	31,900	⅔ Crystalline.
3	slight	1.32	....	40,750	Fibrous.
4	much	1.53	....	27,300	Fibrous.
5	slight	1.76	....	46,600	Crystalline (2 fractures).
6	slight	1.53	....	44,600	Crystalline.
7	slight	1.53	26,100	46,200	Crystalline.
8	very slight	1.53	30,000	42,450	Fibrous.
9	slight	1.76	19,350	26,075	Crystalline.
11	slight	2.00	16,500	27,075	Crystalline.
12	slight	1.76	27,430	43,300	Fibrous.
SUMMARY.					
Minimum			16,500	26,075	
Maximum			30,000	46,600	
Average			23,880	37,350	
Average ratio of yield-point to ultimate strength, 63.6%.					

Newburyport failed to find any such item for a period going back twenty years or more.

The bridge began to be used for horsecar transportation about 1870 and in 1891 the road was electrified so that heavy electric cars began to pass over the bridge regularly after it was eighty years old. The vibration of the half of the bridge over which the tracks were laid finally became excessive under the moving load of heavy cars and the vertical distortion was 3 ft. It was finally decided to strengthen this one roadway of the bridge and a contract for that purpose was let to the John A. Roebling's Sons Co. in 1894.[23]

Short 12×18-in. oak beams were blocked up 7 ins. above the tops of the old caps to span the old chain bearings. These carried cast-iron saddles in which 2-in. twisted steel cables were swung, estimated to have 164 tons ultimate strength each. These cables were in the plane of the old cables 20 ins. above them at the saddles and 26 ins. above them in the middle. The ends were anchored in the same pits with the chains, but 10 ft. farther back, or 106 ft. from the centers of the towers. An excavation here was filled with concrete around a cast-iron anchor plate placed perpendicular to the cable. Collars of flat iron clamped on the cables engaged a ⅞-in. round stirrup suspender which went round a 6×12-in. floorbeam and bolted to a bearing plate, which was beneath. New floorbeams were set close to the old ones and the old stirrups were provided with turnbuckles like the new ones. No floorbeams rested directly on the cables in the new construction. The floor was stiffened by a pair of combination Howe trusses 5½ ft. deep with 7½-ft. panels extending from tower to tower. The vibration was found to be inappreciable under the moving load of a 32-ton car. The contractors found the old ironwork in good condition and not much corroded even where the "unprotected" anchor chains were 10 ft. deep in loose earth. The tower timbers were found to be in excellent condition, but 30% of the spikes in the flooring were found to be sheared off.

In the late summer of 1909 the chain bridge was closed to travel, under the assumption that it had become unsafe, especially for the modern heavy electric cars. Travel at this point was interrupted for about a year while a new wire cable suspension bridge was being built.

The Holbrook, Cabot & Rollins Corporation, of Boston, Mass., furnished the writer a number of links taken from the chains of the bridge when it was removed. These were tested and analyzed as described below.

STRENGTH TESTS.—The chain links were tested in direct tension, the load being transmitted to the links by U-shaped half-links of 1¼-in. round steel. The latter were gripped by the wedges of a 400,000-lb. testing machine so that the application of the load was in all respects similar to the manner of loading of the links in actual service in the suspension chains. These tests were made by students in regular laboratory classes. Two typical links are sketched in Fig. 3.

The results of the tests are summarized in Table I. The average of yield-point was about 24,000 lbs. per sq. in., and the average ultimate strength about 37,500 lbs. per sq. in. It is interesting to note here the fact that the three links of highest tensile strength (Nos. 5, 6, and 7) showed a crystalline fracture, and the fourth (No. 12) broke in a weld, though not in the plane of the weld. Of the five links showing the lowest strength, three (Nos. 1, 2, and 4) showed a fibrous break, one (No. 9) showed a crystalline break, ¼ of which was corroded and therefore of long standing, and one (No. 11) showed a crystalline fracture.

One other fact was shown by examination of the links: the degree of corrosion is greatest on the links showing a very fibrous fracture and much less in the case of the links showing a decidedly crystalline fracture.

Link No. 5, which stood highest in strength, broke suddenly on both sides of the welded end. The coarsely crystalline fracture of this link is shown very well in Fig. 5. Bar No. 4 failed almost entirely in the plane of one of the end welds, but the metal was torn to a certain extent (Fig. 6). The weld surfaces were somewhat corroded in places.

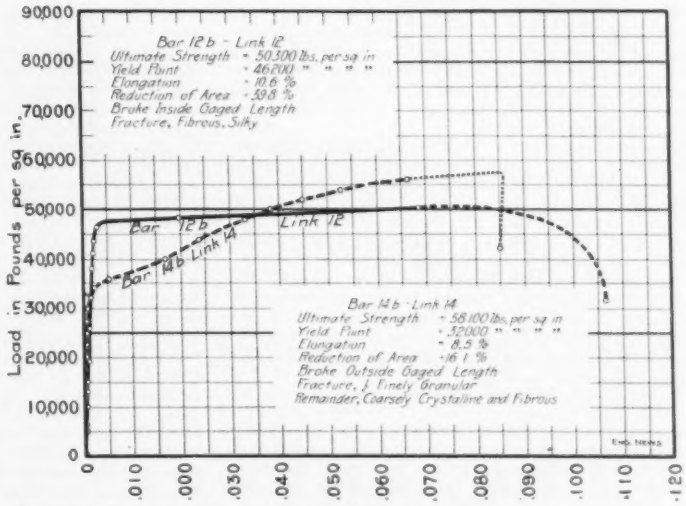


FIG. 7. TWO TYPICAL STRESS-STRAIN CURVES FROM TENSILE TESTS OF BARS CUT FROM LINKS OF NEWBURYPORT BRIDGE.

Figs. 4 and 6 show how the bars were always left larger at the ends than in the central part of the links, though this enlargement does not provide the "two or three times as much metal" called for by the inventor, Mr. Finley. The fact that in no case did failure occur more than 3 ins. from the weld, if not in the weld itself, would indicate that the inventor's directions might well have been more explicitly followed.

Link No. 10 was found to be entirely broken in the weld when only a few thousand pounds had been applied, the strength of the link being represented simply by the power of the side bars to resist bending when loaded as a hook. The test of this link is therefore not reported. Its individual sides were, however, subsequently tested as straight tensile specimens.

It may be concluded that the strength of these old chains was originally certainly not more than 60,000 lbs. each, unless the deterioration has been much more than the appearance of the iron would seem to indicate. Therefore Mr. Finley, in computing the strength of the link to be twice that of the bar iron used and assuming the latter to be capable of withstanding a stress of 60,000 lbs. per sq. in., has really figured his chains at about twice their actual strength to-day. Calling the efficiency of the link the unit strength shown by the link divided by the lowest value of unit strength shown by the subsequent direct tensile tests of the two straight portions of the same link we obtain the following values:

Link number..	1	2	3	4	7	8	9	11	12
% Efficiency...	79.2	67.8	92.2	63.3	94.6	83.2	60.8	47.3	86.0

Average % Efficiency = 74.9%.

The efficiency is therefore only ¾ that assumed by Mr. Finley, but even then it compares favorably with the efficiency shown by the average modern forged chain. It must be remembered, however, that these links did not show the degree of enlargement at the ends called for by Mr. Finley and supposedly counted upon in his assumption of 100% efficiency.

TEST BARS FROM LINKS.—After completing the

[23]H. C. Hovey in the "Scientific American," Oct. 17, 1896.

TABLE II.—TENSILE TESTS OF BARS FROM LINKS OF NEWBURYPORT CHAIN SUSPENSION BRIDGE, AFTER 100 YEARS' SERVICE.

Link No.	Area of cross-section, sq. ins.	Yield-point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation in 8 ins.	Reduction of area.	
1	0.810	35,200	50,650	12.5%	29.4%	Ragged fibrous.
	0.893	35,850	47,100	8.1%	21.9%	Ragged fibrous.
2	1.063	30,580	52,210	7.2%*	7.4%*	90% crystalline.
	1.052	30,430	46,600	13.8%	30.1%	⅔ fibrous.
3	0.751	43,900	49,000	9.0%	49.5%	Ragged fibrous.
	0.795	30,800	44,250	15.6%	43.3%	Fibrous.
4	0.893	35,800	47,000	8.1%	22.0%	Ragged fibrous.
	0.844	35,550	40,280	6.9%*	41.2%*	Ragged crystalline in spots.
7	0.832	46,300	52,670	2.8%*	9.7%*	⅔ crystalline.
	0.918	34,830	48,800	13.0%†	23.3%	Fibrous.
8	0.764	....	51,100	2.5%†	26.7%*	Ragged fibrous.
9	0.805	26,700	47,700	15.6%	35.4%	Fibrous.
	0.817	30,660	42,850	12.8%†	41.8%	Ragged fibrous.
10	0.836	30,500	45,720	15.6%	26.0%	Fibrous.
	0.817	38,600	48,950	5.0%	40.6%	Fibrous.
11	1.016	42,300	57,200	13.1%	35.4%	Fibrous.
	1.017	40,320	62,920	15.0%†	18.4%	Crystalline.
12	0.788	52,000	54,550	0.5%*	....	Coarsely crystalline.
	0.779	46,220	50,300	10.6%	39.8%	Fibrous.
14	1.225	30,000	41,000	9.4%	44.5%	Ragged fibrous.
	1.156	32,000	58,100	8.5%*	16.1%	¼ coarsely crystalline.
16	1.136	40,000	55,000	2.4%*	1.29%	Finely granular.
	1.080	29,000	40,750	4.5%*	44.1%	Ragged fibrous.
18	1.105	30,000	52,000	1.9%	0.25%	Finely crystalline.
	1.096	26,000	42,750	11.0%*	34.4%	Ragged fibrous.
20	1.012	32,000	41,800	0.9%*	56.7%	Ragged fibrous.
	1.088	32,000	53,450	14.8%	43.2%	Ragged silky.

*Broke outside gaged length.
†Gaged length 6 ins. instead of 8 ins.
Note.—Links 1 to 9, inclusive, also 11 and 12 tested as links before cutting the bars for test. Links, 10, 14, 16, 18 and 20 had not been thus stressed.

series of tests of the links described above, the straight portion of each link was cut out and tested alone. The elongation and set of the specimens under increasing loads were read by means of vernier dial extensometers reading to the nearest 0.00005-in. The results are summarized in Table II. Two typical stress-strain curves are reproduced in Fig. 7.

The bars from links 1 to 12 (except No. 10) had been previously stressed to the degree indicated by the breaking stress of the links. Because of the anticipated effect of this preliminary stressing upon the elastic limit and ultimate strength shown by subsequent test, bars from links that had not been previously broken were tested in exactly the same manner, viz., links 10, 14, 16, 18 and 20.

Comparing the two series of bars, it is found that the preliminary stressing increased the average yield-point from 32,000 lbs. per sq. in. to 37,420 lbs. per sq. in., or 17%; the average maximum stress from 47,950 to 49,720, or 3.7%; and ratio of yield-point to maximum stress from 67.3% to 75.4%, or 12%.

In contrasting the properties of the bars which showed a crystalline fracture with those which showed a fibrous fracture, attention is called to the following facts: The bars showing crystalline structure in the first series of tests have 27% higher yield-point, 17% higher maximum stress and 7.4% higher ratio of yield-point to maximum stress than the bars showing fibrous structure, while the latter bars show 80% higher ductility as measured by the reduction of area at rupture. The conclusions that may be drawn from the above comparison are not corroborated by reference to the tests of the second series, but this latter comparison is considered invalidated because only three bars out of ten showed crystalline fracture.

CHEMICAL ANALYSIS OF THE IRON.—The peculiar properties of the wrough-iron shown by the above tests and particularly by the granular or crystalline fracture often encountered (the latter accompanied by higher yield-point, higher ultimate strength, and much lower ductility), and above all the remarkable freedom of the iron from extensive corrosion, led to a study of the chemical constitution of the iron in an effort to explain why it has proven so much more serviceable than modern iron is.

The first sample of the iron analyzed was a composite sample taken from eight links. Later analyses were made upon very large samples taken from links Nos. 5 and 6 exclusively. The latter analyses checked the first one so closely that the average results obtained from repeated analyses of the iron from Bars Nos. 5 and 6 may fairly be taken to be representative of the iron of all the links. The writer wishes here to acknowledge his indebtedness to Dr. G. E. F. Lundell, of the Department of Chemistry, Cornell University, whose interest in the investigation has done much to further the purposes of the writer. The analysis follows:

TABLE III.—CHEMICAL ANALYSIS OF LINKS FROM NEWBURYPORT CHAIN BRIDGE.

	%
Carbon, graphitic	0.100
Carbon, combined	0.000
Total	0.130
Silicon	0.015
Sulphur	0.007
Manganese	0.006
Phosphorus	0.055
Copper	0.350
Nickel	0.040
Tellurium	Trace
Slag	0.220
Iron (by difference)	99.207

It will be noted that the analysis shows the silicon, the phosphorus, and especially the manganese and the sulphur, to be very low; this was, however, to be expected perhaps of iron known to have been made in Sweden or Norway, where the purest ore in the world was then obtained. That the slag amounted to only 0.22% was a great surprise. When we consider that this iron was doubtless made either in a Catalan forge or some other primitive type of charcoal hearth in which it was impossible to obtain a sufficient temperature to more than reduce the iron to a spongy or pasty mass, it seems remarkable that the slag could have been so completely excluded. Wrought-iron made to-day in a reverberatory wet-puddling furnace can scarcely be expected to contain less than 2 or 3% slag, in spite of improved mechanical devices for squeezing it out.

COPPER IN THE IRON.—By far the most interesting and, it is believed, the most significant discovery revealed by the analysis was the existence of 0.35% of copper in the iron. Copper is an element the influence of which in iron and steel has been until very recently a matter either of ignorance or misapprehension. It has often been asserted that its action is similar to that of sulphur in causing red-shortness and making welding difficult, and that it is therefore an undesirable element in wrought-iron. That this idea is erroneous will, in the opinion of the writer, soon be generally accepted as it is now by some of the highest authorities.

W. Lippin[24] found that the addition of copper to Swedish charcoal iron increased the relative fluidity and the fractured surfaces became more and more coarsely crystalline and brighter as the copper percentage rose; 4.9% copper increased the tensile strength from 19 to 22 tons per sq. in., and did not tend to retain the carbon in a combined state.

Mr. J. E. Stead and Mr. F. H. Wigham[25] made extensive tests upon the effect of copper in iron and steel, from which the following single extract is made concerning the effect of copper upon the corrosive resistance of steel: A steel containing 0.42% carbon and 0.48% copper showed a loss of 8.9% by weight when corroded by long immersion in water while steel of practically the same composition but without the copper showed a loss of 10.6%.

Mr. F. H. Williams[26] found even more marked results. With a wrough-iron sample containing 0.393% copper, the loss in an atmospheric corrosion test was 0.53%, while the loss of ordinary wrought-iron not containing copper was 0.81%.

Wigham found that with steel containing gradually increasing percentages of copper, but not exceeding 1.0% of that metal, the tensile strength increases with increasing percentages of copper, and the advantages attending the presence of copper are the more clearly marked the lower the percentage of carbon present in the metal.

Pierre Breuil has probably done the most extensive research work upon the influence of copper in steel, and from his writings[27] the following facts of present interest are gleaned: Steel containing 0.158% carbon and 0.49% copper was found to be about 6% harder than steel of the same carbon content without the copper. Comparing the same two steels further, the copper-steel had about 30% higher tensile strength, 10% lower shock resistance in steel tested as rolled, and an increased loss of shock resistance in steel subjected to subsequent heat treatment.

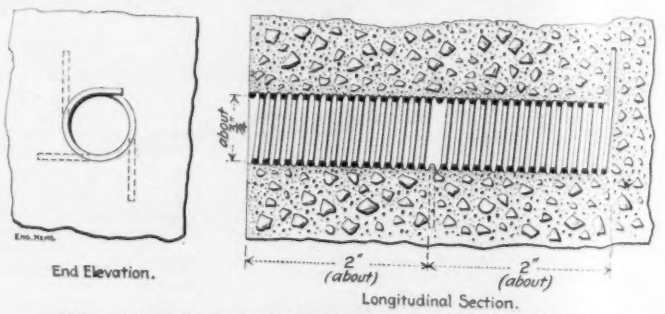
Breuil also made corrosion tests, using a 5% solution of sulphuric acid. The copper-steel above mentioned showed a corrosion loss of 4.40% in weight as compared with the corrosion loss of 5.23% for the ordinary steel, a decrease in corrosion loss in favor of the copper steel of 16%.

The purpose of the writer in citing the above facts brought out by various investigators has been simply to support the theory which we have arrived at in attempting to explain the peculiar properties revealed by the tests of this old Norway iron; namely, that the crystalline fracture often observed is primarily due to the presence of the copper, probably in greater amounts in the iron showing the most pronounced crystalline fracture. Also that the freedom from corrosion is largely due to the presence of the copper and not merely due to the purity of iron, though it is well known that pure iron is much less corrosive than impure iron. This view is supported by the fact that an examination of the links tested shows that the most badly corroded ones invariably reveal a fibrous structure while those which revealed a coarsely crystalline fracture were most remarkably free from corrosion. The theory that the bars showing the crystalline structure owe that structure to a somewhat higher copper content is further substantiated by noting the facts brought out in the summaries of tests above; namely, that the iron of crystalline fracture showed higher tensile strength and elastic limit and lower ductility than did the iron of fibrous structure, which findings are exactly in accord with the conclusions of the investigators just cited.

[24]Journal of the Iron and Steel Institute, 1900. No. II.
[25]Journal of the Iron and Steel Institute, 1901. No. II.
[26]"Iron Age," Nov. 29, 1900.
[27]Journal of the Iron and Steel Institute, 1907. No. II.

A New Bolt Socket for Concrete Construction

The accompanying cut shows a very simple and effective type of bolt socket to be inserted in concrete, recently patented and now manufactured by Mr. David Craig, 70 Broad St., Boston, Mass. It is made by forming a round wire into a helical coil just fitting into the thread of a lag screw or bolt, leaving the ends of the wire extending tangentially from the circle of the helix. This formed wire is then placed on a so-called "master bolt" and placed through the form in which concrete is to be poured, and the concrete poured around it. When the concrete has set the "master bolt" is removed, leaving the wire to form the female screw in the concrete, into which the bolt may be screwed at any time. It will be noted that the ends of the wire protrude into the concrete, forming an effective reinforcement of the concrete, as well as holding the screw bore firmly in place.



End Elevation. Longitudinal Section.

SCREW SOCKET FOR CONNECTING BOLTS TO CONCRETE.
(Made from a spirally bent wire.)

These sockets are made in various sizes and lengths, the latter being short, so that if a long bolt is required the socket may be in two or more pieces, each piece with its protruding ends acting to hold the socket in place.

The main use of such a socket is to provide means for attaching hangers of whatever sort to the members of reinforced-concrete structures, but the Craig socket has been most successfully used by the Boston Elevated Ry. in separately molded concrete work to tie together two adjoining pieces.

It should be noted that with this socket, as in all other metallic sockets, insulation should be provided to prevent the transmission of any electric current to the reinforcement.

The Economical Design of a Reinforced-Concrete Floor Panel.

By J. NORMAN JENSEN.*

Because of the fact that there are at least three variables in the cost of any reinforced-concrete work, an economical design of a reinforced-concrete floor panel is oftentimes difficult of solution. It has been the aim of some writers to express the relations necessary for maximum economy by means of a formula. The aid of the calculus has even been invoked in its derivation. In every case the cost of the formwork has not been included in the formula given, or has been lumped in one glorious integer with the cost of the concrete. When it is remembered that the cost of formwork may be one-third of the cost of the job, it is readily seen that this is too big an item to be overlooked.

The curling tail of an integral sign may express results which are of more or less value, but to the writer it seems that the "cut and try" method is the best in the problem at hand. Instead of taking the slab or the beam as a measure of the relative economy of design, a whole panel has been used, as it is believed that this is the logical way to study any design. When the panel loads are known the design of columns and footings may be worked out to the best advatnage.

A typical interior panel has been designed in 14 different ways and an analysis made of the cost of each. The whole design was based in general on the Revised Building Ordinance of the City of Chicago. A summary of the sections which have a direct bearing on the design of the panel is given verbatim below. In order that all designs should be on the same basis it was necessary to impose in each case the same general conditions of design.

GENERAL CONDITIONS OF DESIGN.

Size of panel, 20 × 20 ft.
Live load = 100 lbs. per sq. ft.
Dead load = Weight of 1-in. granitoid floor finish + plaster ceiling + floor construction.
Ceiling to be plastered. Flat ceiling preferred.
Maximum depth of beam or girder allowed = 24 ins.
1:2:4 Concrete.

SUMMARY OF BUILDING ORDINANCES BEARING ON DESIGN.

Unit tensile stress in steel	= 18,000	lbs. per sq. in.	
" Bending compression in extreme fiber	= 700	"	"
" tension in concrete on diagonal plane	= 40	"	"
" bond stress	= 100	"	"
Ratio of moduli of elasticity	= 15.		

The steel to take all the tension.
The stress-strain curve of concrete in compression is a straight line.
Bending moment in middle of intermediate span = $\frac{wl^2}{12}$.
Span for continuous beams = distance between centers of supports.
Span for freely supported slab = the free opening plus the depth.
Web reinforcement provided where vertical shear measured on the section of a beam or girder between the centers of action of the horizontal stresses exceeds 40 lbs per sq. in.
Vertical shear measured as stated above shall in no case exceed 133 lbs. per sq. in.
For T-beams the width of the stem only shall be used in calculating the above shear.
Width of flange in T-beams limited to a width of one-third the span of rib, and also to three-fourths the distance c. to c. of ribs.
Where reinforced-concrete girders support reinforced-concrete beams, the portion of floor slab acting as flange to the girder must be reinforced with rods near the top, at right angles to the girder.
Steel shall nowhere be nearer the surface of the concrete than 1½ ins. for beams and girders, and ½-in., but not less than the diameter of the bar for slabs.
Thickness of concrete between the separate pieces of steel in beams and girders shall not be less than 1½ times the maximum sectional dimension of the steel.
For square slabs with two-way reinforcements the bending moment at the center of the slab shall not be less than $\frac{wl^2}{24}$ for intermediate spans.

The formulas used in the design are those recommended by the Joint Committee on Concrete and Reinforced Concrete. In some cases transpositions of some of these formulas have been used, and additional formulas derived in the same general way have been utilized. The standard notation adopted is as follows:

M = bending moment or resisting moment.
A = steel area.
b = width of beam.
d = depth of beam to center of steel.
k = ratio of depth of neutral axis to depth d.
j = ratio of lever arm of resisting couple to depth d.
K = constant = coefficient of strength.
$p = \frac{A}{bd}$.
z = depth of resultant compression below top.
$jd = d - z$ = arm of resisting couple.
b = width of flange of T beams.
b' = width of steam of T beams.
t = thickness of flange of T beams.
V = total shear.
v = shearing unit stress.
u = bond stress per unit area of bond.
V_c = total allowable shear on bd.
s = spacing of stirrups.
o = perimeter of bar.
Σ_o = sum of perimeters of all bars.

The following formulas have been used in the design.

Rectangular beams and slabs.

$$K = \frac{f_c^2\, n\, (3 f_s + 2 n f_c)}{6\, (f_s + n f_c)^2}$$

$$P = \tfrac{1}{2}\, \frac{1}{\frac{f_s}{f_c}\left(\frac{f_s}{n f_c} + 1\right)}$$

$$M = K bd^2$$

$$A = P bd$$

$$K = \sqrt{2 p n + (p n)^2} - p n$$

$$J = 1 - \tfrac{1}{3} K$$

T beams.

$$Kd = \frac{n f_c d}{f_s + n f_c}$$

$$Z = \frac{3 Kd - 2 t}{2 kd - t}\, \frac{t}{3}$$

$$A = \frac{M}{f_s (d - z)}$$

$$b = \frac{2 n (d - Kd)}{t (2 Kd - t)} A$$

Bond and shear.

$$U = \frac{V}{\frac{7}{8} d \Sigma_o}$$

$$V = \frac{V}{\frac{7}{8} b'd}$$

$$S = \frac{\frac{7}{8} d f_s A}{V - V_c}$$

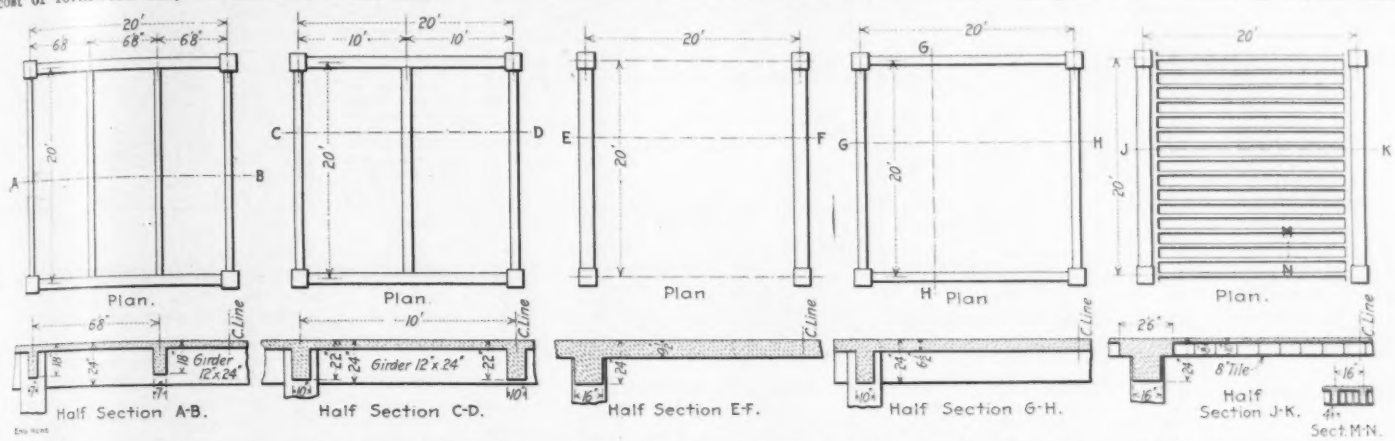
The three variables entering into the cost of a reinforced-concrete job are steel, concrete and formwork. In some of the designs the cost of hollow tile enters in as a fourth variable.

Steel is usually quoted as base, f. o. b. Pittsburg. By the term base is meant the price per 100 lbs. for ¾-in. bars or larger. There are additional charges for bars smaller than ¾-in; ⅝-in. bars costing 5 cts., ½-in. bars 10 cts., ⅜-in. bars 25 cts., and ¼-in. bars 50 cts. per 100 lbs. more than the base price. That is to say that if the price f. o. b. Pittsburg is $1.35 base, in car load lots, the price for ½-in. bars would be $1.45 per 100 lbs. To these prices f. o. b. Pittsburg must be added the freight rate to the job in question. For instance the car load rate on bars to Chicago from Pittsburg is 18 cts. per 100 lbs. The base price fluctuates more or less, but at present writing is $1.35 f. o. b. Pittsburg for deformed bars, cut to lengths.

The unit prices for the steel given for each design, are the prices for the steel in place. These include the cost of hauling to the job from the cars, unloading, bending slab bars, beam bars and stirrups, placing into the forms, and doing all necessary wiring.

Concrete may be subdivided into the cost of the cement, sand, gravel or crushed stone, water, and the labor in mixing and placing. As a general rule the cement mill nearest the job can furnish the cement the cheapest, as freight charges are a big item in the cost. The length of haul from the cars to the job is another large factor in the cost of the cement. Sand and gravel or crushed stone are usually quoted f. o. b. the job, the distance from the job to the local pit or quarry entering largely in the cost of the material. Water is generally a small item and does not run more than 3 cts. per cu. yd. Cement in the Chicago market is quoted at $1.25 per bbl., sand $1 per cu. yd., gravel $1.45 per cu. yd., crushed stone $1.65 per cu. yd. The above prices are all f. o. b. the job for an ordinary haul. The labor of mixing by machinery, hoisting and wheeling has been placed at $1.70 per cu. yd. This last item also includes a small allowance for the incidental expenses incurred by the hoisting and mixing plant, and also an allowance for the unavoidable delays which always occur on any job.

In the cost of formwork given for each design, it is assumed that the floor framing is typical and that the forms can be used three times. The labor cost includes the cost of making, setting, bracing, removing, cleaning and erecting again. The cost of the material includes nails, wire and all lumber used in the forms, also the posts and braces used in supporting the same. The cost of lumber has been figured at $22 per M. for yellow pine. The cost of labor varies with the design, and is included in the unit cost given for each case. The cost



Design No. 1.—Solid Slab, Intermediate Beams at Third Points.

Design No. 2.—Solid Slab, Intermediate Beam in Middle.

Design No. 3.—One Way Solid Slab.

Design No. 4.—Two Way Solid Slab.

Design No. 5.—One Way Hollow Tile Slab.

FIGS. 1-5.

*Civil Engineer, 1518 N. Leavitt St., Chicago, Ill.

of slab and beam forms is given as so many cents per square foot. Slab forms are measured center to center of columns. Beam forms are measured by the square feet of surface in contact with the concrete. Thus a beam 12 × 24 ins. under the slab would have 5 sq. ft. of forms per lin. ft. of beam. Beams are measured face to face of girders, and girders face to face of columns in computing the length of each. It is assumed that the girders frame into an 18-in. column in each design.

The present union scale for form carpenters is 60 cts. per hour, and for laborers 37½ cts. per hour for an eight-hour day. The unit prices given in this article do not include contractor's profits.

A plan and a section of a typical interior panel is shown in each design. The plan is taken looking upwards. The designs in which hollow tile is used show the concrete ribs between the tile. Hollow tile floors would present a flat ceiling and there would be no line of demarcation between the hollow tile and the concrete rib, but it is believed that the design is more clearly brought out by showing the floor this way. In some of the last designs the flare of the column and the square column cap is indicated. In each case a half section is given of double the scale of the plan.

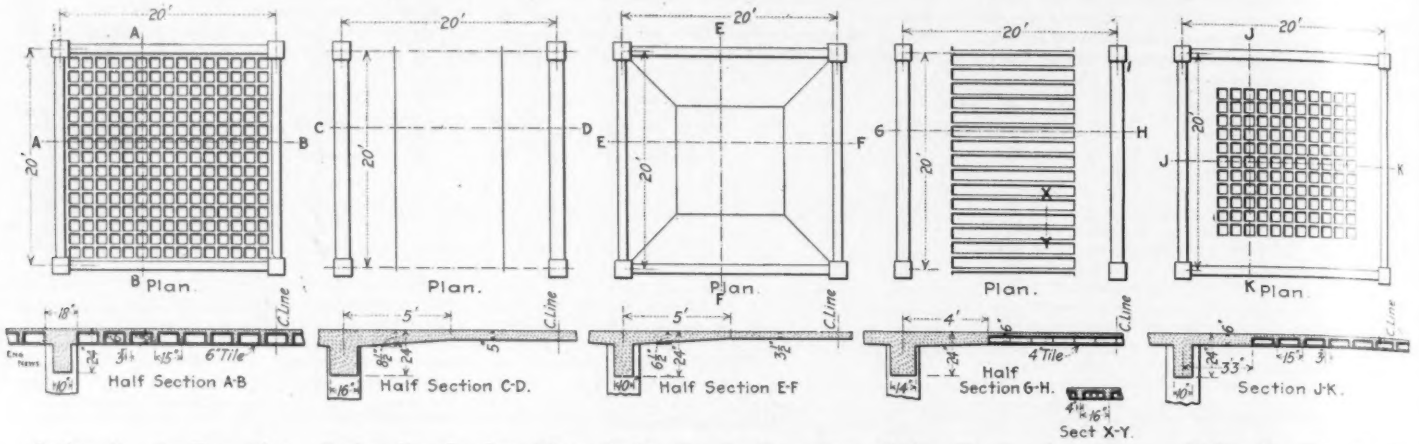
construction in which the load is carried from the slab into the beam, from the beam into the girder, and thence into the column. The full live load has been taken on the girder. This and the next design represent the earlier forms of framing in which the beams and girders have been laid out in imitation of standard steel framing.

The slab has been designed as a continuous beam, with the same steel over the support as in the center of the span. This is accomplished by bending each slab bar at one end in order to provide for negative bending moment. The straight end of each bar bears on the beam and the bent end terminates at the quarter point beyond the center line of the next beam. The bent and the straight ends of the bars alternate. This method of placing slab bars saves considerable steel, and it is believed gives more satisfactory results than using straight top bars. The trouble with straight slab bars over the beams is that one never knows whether these top bars are in the position they are intended to be or not, as there is always danger that they may sink into the "soupy" concrete. Slab bars as described above cannot become misplaced if they are properly bent and placed in the bottom of the slab. It is believed that the increased expense of bending these slab bars is offset by

The beam has been designed as a T-beam. Half of the bars in the bottom of the beam have been bent up at the quarter point and extend to the quarter point beyond the center line of the column in both directions. In this way the same amount of steel is obtained over the support as in the center of the span. Ordinary ⅜-in. round single loop U-stirrups have been used.

In the design of the girder the bending moment has been figured as a simple supported span, and then a reduction has been made for continuity. Bars have been bent up similarly to the beam, and a close spacing of stirrups maintained to take the diagonal tension. In order to provide for loads which might be transmitted directly to the girder, ½-in. square top bars 5 ft. long were placed near the top of the slab over the girder for its full length.

The cost of the steel has been placed at 3 cts. per lb., and the concrete 20 cts. per cu. ft. Slab forms have been estimated at 8 cts. per sq. ft., and beam and girder forms at 10 cts. per sq. ft.



Design No. 6.—Two Way Hollow Tile Slab.

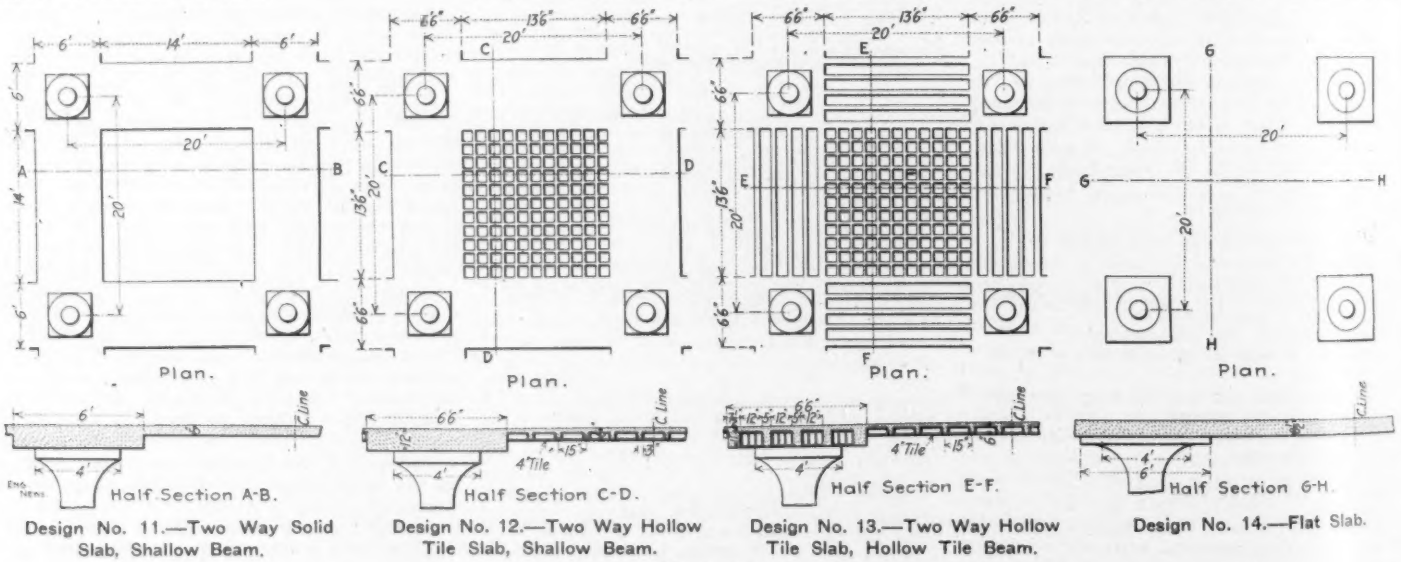
Design No. 7.—One Way Cantilever, Solid Slab.

Design No. 8.—Two Way Cantilever, Solid Slab.

Design No. 9.—One Way Cantilever, Hollow Tile Slab.

Design No. 10.—Two Way Cantilever, Hollow Tile Slab.

FIGS. 6-10.



Design No. 11.—Two Way Solid Slab, Shallow Beam.

Design No. 12.—Two Way Hollow Tile Slab, Shallow Beam.

Design No. 13.—Two Way Hollow Tile Slab, Hollow Tile Beam.

Design No. 14.—Flat Slab.

FIGS. 11-14.

Special items of interest in the design, construction and cost of each design will be taken up in turn. In no case is the steel shown, but a general description of the type adopted is given in each.

Design No. 1.

In this design is shown the common form of the saving in the steel, and a better type of construction results.

A lower unit stress in the concrete than allowed in the ordinance has been used because of the small bending moment. In order to provide for temperature stresses and to tie the main reinforcing bars together, ⅜-in. square bars 24 in. c. to c. have been used.

Design No. 2.

The same general remarks as to the design and the construction of Design No. 1 apply in this design also. The unit prices are the same.

Owing to the increasing cost of formwork, there is a tendency to simplify the framing and eliminate intermediate beams as shown in the first two designs. Architecturally and otherwise a paneled ceiling is objectionable because of its ugly effect. A long span ceiling as shown in the rest of the designs reflects more light and as a result gives a better lighted room than one which is cut up by beams forming pockets which retain the heat and the dust.

Design No. 3.

The framing shown is the simplest type of a slab and beam design. The required thickness of slab is excessive, however. Owing to the fact that the neutral axis comes within the slab, the beam was designed as a simple rectangular beam; ½-in. round stirrups closely spaced were required because of the high diagonal tension. Bent slab bars and beam bars were used same as in Design No. 1. This same construction was used throughout all the designs in which a solid slab and deep beams were used. Unit costs are same as in Design No. 1.

Design No. 4.

The assumption that stresses at right angles to each other act independently allows the design of a two-way slab. As the panel is square one half the load is carried in each direction to the beam. The reduction in the thickness of the slab over the one-way slab is considerable. The increased amount of steel and the extra beam in this design are to be compared with the large amount of concrete used in the previous design. The thinner slab in this design made it necessary to design the beam as a T-beam. The unit costs are the same as in Design No. 1.

Design No. 5.

Long span concrete construction has come to stay. The objection to the one-way solid slab construction is its great dead weight. The dead load of the slab shown in Design No. 3 is 75% in excess of the dead load of the floor in this design, and yet the load carrying capacity of the two are the same. Herein is the main argument in favor of the hollow tile floor. There are other advantages, too. The cost of formwork is about one-third less than in solid slab construction. This is because of the fact that it is not necessary to use tongued-and-grooved stuff in the construction of the forms, as all that is required is a 1 × 10-in. board under each concrete joist. There is not the waste of lumber so common with tongued-and-grooved stuff as the 1 × 10-in. boards are easily placed and easily wrecked. Their salvage value is therefore considerably higher than the lumber for forms where tight sheathing is required.

When a mortar finish is applied immediately after the concrete is poured in this type of a floor, and is left perfectly level, this level surface is not maintained, but there are slight depressions over the joists. This is because of the fact that the 2-in. top coat dries quicker and sets quicker than the joist with its greater body of concrete and greater shrinkage. The top coat dries quicker because the hollow tile absorbs the moisture in the concrete. To prevent this absorption of moisture by the tile, a thorough sprinkling of the tile just before the floor is poured should be insisted on, especially in hot weather.

Referring to the section of the floor it will be noticed that it consists of 4-in. joists with hollow tile fillers between. Over the tile is a 2-in. layer of concrete, previously designated as top coat. The hollow tile is first placed in position on the centering, and the joist and top coat poured. The filler merely acts as a form for the joists and as a convenient surface for plastering. Structurally, it is not considered in the design, and in fact is only so much added dead weight.

The floor joists are designed as T-beams with a 2-in. thick flange. Two bars are placed in each joist, one straight and one bent at both ends and extending to the quarter point beyond the center line of the columns in both directions. This last bar is bent up so as to aid in diagonal tension, and also to provide the same steel over the support as in the center of the span.

In any design in which hollow tile floors are used it is necessary to provide enough concrete in compression in the flange of the beam. In this design a 30-in. flange was required. One-half inch stirrups closely spaced were needed because of the heavy diagonal tension characteristic of this type of a design. Beam bars were bent up in the same way as previous designs.

The following unit prices were used in estimating: steel 3 cts. per lb., concrete 20 cts. per cu. ft., 8-in. tile 9 cts. per piece, slab forms 6 cts. per sq. ft., beam forms 10 cts. per sq. ft.

Design No. 6.

Ordinary hollow tile is open at both ends and cannot be used when the floor is to be reinforced in both directions. Various two-way tile have been put on the market. Each 15-in. square shown in this design consists of four separate pieces so manufactured that when they are placed on the centering they present four closed sides to the joists at right angles to each other. The lower edge of each tile projects 1½ ins., giving an unbroken tile surface for plastering.

The principal objection to the two-way hollow tile is that there are four times as many pieces to handle as in ordinary one-way hollow tile floor. The dead weight is about 25% greater than one-way hollow tile floors of the same total depth.

Half the load was assumed distributed in each direction. The center of gravity of the steel was taken 1½ ins. from the bottom of the floor, and the joist designed as a T-beam. Two bars were put in each joist, one straight and one bent extending to the quarter point.

The beam was designed as a simple rectangular beam with the usual bent bars and stirrups.

Unit prices adopted for this design are the same as the previous design except that the 6-in. two-way tile was figured at 11 cts. per piece.

Design No. 7.

In an attempt to produce a more economical construction, the cantilever slab has been adopted rather widely. The method of design is as follows. A flat slab is designed for a span about one-half the c. to c. span. The portion of the slab from the edge of the flat slab to the beam is designed as a simple cantilever beam carrying the reaction from the flat slab at the end and a uniformly distributed load over the cantilever. In this way the required thickness of the slab at the edge of the beam is obtained. The beam is designed to take the reactions from the cantilevers, and also the live and dead load on the beam itself.

The spacing of the bars in the cantilever portion of the slab is so arranged that it is one-half c. to c. distance of the slab bars. In this way the slab bars may be bent up near the end of the flat slab, and run in the top of the cantilever slab where this steel is needed. The balance of the steel in the cantilever slab is furnished by straight bars which terminate in the flat slab about 1 ft. from the shallow end of the cantilever. Temperature bars 24 ins. c. to c. are used in both the slabs. The arrangement of steel in the beam is the same as in previous designs.

Owing to the more complex slab form construction, the cost per square foot has been estimated at 8½ cts. Beam forms have been taken at 10 cts. per sq. ft., steel at 3 cts. per lb., concrete at 20 cts. per cu. ft.

Design No. 8.

This design represents a cantilever slab in which the center flat slab is reinforced in both directions, as one-half of the load is assumed to be carried in each direction. The cantilever slab has been designed to take the reaction from the two-way slab and also the full uniformly distributed live and dead load on the cantilever itself. As in the previous design the beam has been designed to take the reactions from the cantilevers and also its dead and live load.

The arrangement of steel is similar to Design No. 7 except that temperature bars are not used in the flat slab because of the two-way reinforcement.

This method of design results in a reduction in the concrete quantities over the previous design and a considerable increase in the steel quantities. A vaulted ceiling effect is produced which may or may not be desirable. The formwork for the slab is rather difficult and has been placed at 9½ cts. per sq. ft. Except for this item the unit prices are the same as in Design No. 7.

Design No. 9.

The only difference between this and Design No. 7 is that a hollow tile slab has been substituted for a solid slab. The hollow tile slab has been designed as a T-beam in the usual way. Two bars were required in each rib, one straight, and one bent up to aid in the cantilever slab. Other features are similar.

Unit prices are the same as in Design No. 7, with the addition of 5½ cts. per piece for the 4-in. hollow tile.

Design No. 10.

Although this is called a cantilever design the vaulted ceiling of the previous designs is not obtained. This is because of the fact that the depth of the cantilever happens to become the same as the hollow tile slab. The method of design is similar to Design No. 8 except that the hollow tile floor is designed as a T-beam. The arrangement of steel is similar to Design No. 9. Steel has been figured at 3 cts. per lb., concrete 20 cts. per cu. ft., 4-in. tile 10 cts. per piece, slab forms 8 cts. per sq. ft., beam forms 10 cts. per sq. ft.

Design No. 11.

Ordinarily a shallow beam is not economical. In warehouse construction the height to which goods may be piled is limited to the distance between the floor and the under side of the deepest beam of the floor above. In this design there is a saving of 1 ft. in head room over the previous design. This means a saving of 1 ft. of brickwork on all exterior walls and also a saving of 1 ft. of column for each floor. Thus a shallow beam design may work out to be economical when the building as a whole is taken, although a typical interior panel may not appear so.

As a preliminary step the width of the shallow beam was assumed. The two-way slab between was designed in the usual way. The shallow beam was designed to take the load from the slab and also the full live and dead load on the beam itself. It was considered as a rectangular beam, and the depth to the center of the steel obtained since the width was known. Because the diagonal tension was low, no stirrups were used, but one-half the beam bars were bent at each end at about the quarter point. To keep these beam bars in position a tie bar was placed at each end of the beam.

No elaborate beam forms are required in this design, as the whole panel is practically a flat slab. Steel has been estimated at 3 cts. per lb., concrete 20 cts. per cu. ft., slab forms 8½ cts. per sq. ft.

Design No. 12.

This design is identically the same as the previous one except for the substitution of a hollow tile slab for a solid slab. Unit prices are the same with the addition of 10 cts. per piece for the 4-in. two-way hollow tile.

Design No. 13.

A study of the two previous designs discloses the fact that the dead load of the panel is comparatively great. For all designs in which the span and the load of the slab has been the same it has been found that the dead load of the hollow tile floor has been considerably less than the corresponding solid slab floors. Believing that the same general principles could be used in the beam itself, this design was originated by the writer.

The slab was designed as in previous designs of this kind. One bar was placed in each joist, straight at one end and resting on the end joist of the hollow tile beam. The other end of the bar was bent up and extended to the quarter point of the 13-ft. 6-in. span. The beam was designed to take the load from the slab, and also the dead load of the concrete and the tile and the live load of the beam itself. The moment thus found was distributed equally on the beam joists, and the joist designed as a T-beam. Two bars were placed in each joist, one straight and one bent extending to the quarter point beyond the edge of the cap in both directions.

Steel was figured at 3 cts. per lb., concrete at

20 cts. per cu. ft., 4-in. two-way hollow tile at 10 cts. per piece, 8-in. tile at 9 cts. per piece, slab forms at 8 cts. per sq. ft.

Design No. 14.

Reinforced concrete has an individuality of itself. To the writer the imitation of standard steel and timber framing is inconsistent and unnecessary. Why is it necessary to assume that the load travels from the slab into the beam, from the beam into the girder, and from the girder into the column? Tests of full size panels show that the load tends to travel directly to the column. This fact is evidenced by the diagonal cracks which form when a nearly square slab is tested to destruction, and seem to conclusively show that the stress does not travel around a corner as we assume.

The advantages of the flat slab over other forms of construction may be summarized as follows:

1. Absence of beams with resulting low cost of formwork.
2. Simplicity of reinforcement.
3. Increased available headroom.
4. Ease of installing sprinkler system.

These items will be taken up in the order given.

Lumber is becoming more scarce and higher in price. The demands of trades unions are such that it is no longer possible to use ordinary labor in the rough part of formwork, but a union carpenter must be employed. So far it has seemed impossible to develop a system so that metal forms can be used in a building. For this reason some contractors bid high when there are beams in a job, but will bid low on a girderless floor shown in the design.

The absence of beams means the absence of the troublesome bending and placing of the beam steel. No bending of slab bars is required as long bars of small diameter are used, and these are allowed to sag into the position for which they are designed. The distributing bars of the column head are bent, but the cost is small.

As pointed out in design No. 11, any increased available headroom means a decided saving when the whole building is involved. The difference of 1 ft. 3½ ins. in headroom between this design and the earlier designs is such a large difference that it may be a determining factor.

It is difficult to install a sprinkler system when the ceiling is cut up with beams. The perfectly flat ceiling of this design makes such an installation extremely simple.

Flat slabs have been studied in research laboratories and also in the field. In both cases the fact has been brought out that the stress over the support is considerably higher than in the center of the span. In some experiments there has been such a marked difference that it seems that the important thing is to study the stresses at the support, and if these are correctly analyzed the stresses at the middle of the span would be a comparatively simple matter.

There are almost as many opinions as to the design of a flat plate as there are engineers. No two authorities on this subject agree as to the analysis. In the earlier analyses of plates the conclusion was reached that a plate supported on the four corners was stronger than if it were supported on the four edges. On the face of it this is ridiculous. A feeling of distrust in the earlier analyses has been aroused, and a solution sought elsewhere.

Recent tests at the University of Illinois throw considerable light on the correct solution of the problem at hand. At this institution, footings in which the width of base was four times the width of the pier, and wide beams which were supported for one-half or less of their width, were studied. Apparently these tests have no bearing on the flat slab design, but when it is remembered that the column and its cap can be treated as an inverted pier, the analogy becomes more real.

In a paper* read by Mr. Arthur R. Lord, research fellow in the Engineering Experiment Station, University of Illinois, before the National Association of Cement Users, a description of a test of a flat slab was given, and from the information thus obtained various conclusions were arrived at. With these conclusions and the aforesaid mentioned tests in mind an analysis and design of a flat slab was obtained. The method was as follows. A line of inflection was assumed. The square within the line of inflection was considered as an inverted footing with a uniformly distributed load and also with a load along the lines of inflection. Assuming a depth to the center of the steel and knowing the bending moment, the required area of steel was found in the usual way.

Owing to the very small amount of bending, steel was figured at 2¾ cts. per lb., concrete was estimated at 20 cts. per cu. ft., and formwork at 8 cts. per sq. ft.

Summary of Quantities and Costs.

A table showing the quantities for each design is given herewith. The steel quantities represent all the slab and beam steel in the panel. The concrete quantities include everything in the panel except the column cap, which is considered as part of the column. As stated before, slab forms include the area within the center lines of columns, and beam forms are measured by the square foot of surface in contact with the concrete. These quantities for a typical panel are given as it is realized that the unit prices in other localities may vary from those given with the various designs.

The last column gives the panel dead load. This includes the weight of the construction, and also the weight of the plaster and finish for the panel. This last item is a constant quantity for each design. The panel dead loads were inserted to show the relative dead load brought to the columns and footings by each design. As will be noted there is as wide a variation as in the quantities themselves.

A summary of the cost per square foot is given in the last table. This cost per square foot is the cost for the panel only and does not include the cost of the columns or the footing for the typical panel. When the building as a whole is considered the total costs given in the last column will not necessarily indicate the relative cost of each design. Other factors may enter in which would materially change these relations. But it is believed that this last column indicates fair relative costs when the concrete only is considered, for average conditions of labor and material in the Middle West.

Conclusions.

A study of the total costs given in the above table discloses the fact that in every case where hollow tile is used, whether the one-way or the two-way tile is employed, the hollow tile design is cheaper than the similar solid slab design. The most uneconomical design is that in which a long span solid slab is supported on beams on one side of the panel only. A close second to this design is that in which a two-way solid slab is supported by beams on all sides of the panel.

A question is sometimes raised as to the relative economy of one-way and two-way hollow tile. By comparing Design No. 5 with No. 6, and Design No. 9 with No. 10, it is seen that there is a marked difference in favor of the one-way hollow tile design. The two-way hollow tile is in turn more economical than the corresponding solid slab design.

It has been stated that a shallow beam is not economical. By comparing Design No. 4 with Design No. 11, and Design No. 6 with Design No. 12, it is seen that the shallow beam is considerably cheaper than the deep beam design. Of the three shallow beam designs, the design in which hollow tile is used throughout works out to be the most economical. Of all the designs the flat slab appears to be the most economical.

TABLE GIVING SUMMARY OF DESIGNS OF VARIOUS TYPES OF REINFORCED-CONCRETE SLABS.

Quantities.

Design No.	Steel lbs.	Concrete cu. ft.	Tile No. pcs.	Forms Slab sq. ft.	Forms Beam sq. ft.	Panel dead load.
1	1,550	187	...	400	254	35,300
2	1,837	225	...	400	225	40,900
3	1,976	346	...	400	68	59,100
4	2,251	261	...	400	142	46,400
5	1,597	184	262	400	68	41,600
6	1,905	190	225	400	130	46,100
7	1,587	232	...	400	74	42,000
8	1,800	201	...	400	142	37,400
9	1,386	181	180	400	71	37,400
10	1,457	207	121	400	142	41,700
11	1,778	286	...	400	...	50,200
12	1,678	270	121	400	...	51,100
13	1,689	180	121-4-in. 108-8-in.	400	...	40,400
14	1,110	284	...	400	...	49,800

COST PER SQUARE FOOT.

Design No.	Steel. cts.	Concrete. cts.	Tile. cts.	Forms. cts.	Total. cts.
1	11.6	9.3	...	14.4	35.3
2	13.8	11.2	...	13.6	38.6
3	14.8	17.3	...	9.7	41.8
4	16.9	13.0	...	11.6	41.5
5	12.0	9.2	5.9	7.7	34.8
6	14.4	9.9	6.1	9.3	39.7
7	11.9	11.6	...	10.3	33.8
8	13.5	10.0	...	13.1	36.6
9	10.4	9.1	2.4	10.3	32.2
10	10.9	10.3	3.0	11.6	35.8
11	13.4	14.3	...	8.5	36.2
12	12.6	13.5	3.0	8.5	37.6
13	12.7	9.0	5.3	8.0	35.0
14	7.6	14.2	...	8.0	29.8

*Engineering News, Dec. 22, 1910, p. 697; Dec. 29, 1910, p. 716.

Anticorrosive and Antifouling Paints for Ships' Bottoms; Experience of the U. S. Navy.*

By HENRY WILLIAMS.†

Recently, an armored cruiser painted at previous docking with a standard commercial ship's bottom paint was placed in dry dock on the west coast, after having been out of dock 16 months, and was found to be very foul. An estimate of the total weight of barnacles and other growths removed was given as 600 tons, and when undocked the vessel's draft was 4½ ins. less than when docked, other conditions being the same. This was a cruising ship, the itinerary of which, since prior docking, had included cruises to South American ports and the Samoan Islands. Other similar cases where the speed and coal consumption of vessels have been affected considerably by foul bottoms are of common occurrence, and are well known to officers generally.

The question of protecting the underwater bodies of sea-going ships always has been vital, and since the use of steel for hulls has become general, a suitable paint for this purpose has been in demand. Various manufacturers offer commercially, generally under proprietary names, so-called ship's bottom paints or compositions, which are designed to effect the double purpose of protecting the bottom plating from the corrosive action of sea-water and, also, of preventing the attaching of the various marine growths, such as grass, barnacles, hydroids, etc. The necessity for the periodic docking of ships, often at intervals of less than 6 months, bears witness to the fact that so far no satisfactory ship's bottom paint has been produced; those in general use represent the best available, but all leave much to be desired.

Commercial Bottom Paints.

The composition of the various commercial ship's bottom paints, their ingredients, method of manufacture and action are screened by an affected mystery as "trade secrets," by those interested in their sale.

Work toward improving those ship's bottom compositions that give the most satisfactory results is done, generally, by interested producers, who utilize the available results in the improvement of their own product, but suppress all data that might be of advantage to competitors. This may explain the fact that literature on the subject of ship's bottom paints is generally meager, largely theoretical and often misleading.

As a general rule, bottoms of ships are painted with two different kinds of bottom paint, the anticorrosive, applied usually in two coats next to the metal, and the antifouling applied in one coat over the anticorrosive. The function of the anticorrosive is to protect the metal, not only from the corrosive effect (which is very great) of the sea-water, but from the corrosive action of the poison which is included in most of the antifouling paints to kill marine growths. Antifouling paints may be divided generally into two classes, the varnish or "poison paints," which comprise the great majority, and the grease or wax paints, which are of the consistency of soft soap and must be heated to permit of being applied.

The commercial paints consist generally of a varnish made up largly with ordinary resin, in a vehicle consisting of the higher distilling hy-

*Abstract of a copyrighted paper published in the "U. S. Naval Institute Proceedings," June, 1911, reprinted here by permission of Prof. Philip R. Alger, Secretary.

†Naval Constructor, U. S. Navy.

drocarbons, such as benzine or naphtha, and in small quantities of turpentine and linseed oil. The pigments used for the anticorrosive paints are iron oxide, talc, china clay and zinc oxide. The antifouling varnish paints are generally similar in composition to the anticorrosive, but have, in addition, certain poisonous ingredients, the most usual poisons being the red oxide of mercury, copper oxide, arsenic, calomel and corrosive sublimate.

The commoner antifouling grease paints consist simply of a copper soap and a small percentage of copper oxide. The anticorrosive paints used under the grease paints are the same generally as those used with the varnish paints.

In order that the similarity of the various better-known brands of ship's bottom paints may be judged, a brief statement is given of the characteristics of several of these, as determined by chemical analysis by a navy yard chemist:

Comparative Analyses of Various Ship's Bottom Paints.

Paint A.

Anticorrosive: Oxides of zinc and iron with carbonate of lime; in a vehicle containing benzine, resin, linseed oil and turpentine.

Antifouling: Oxides of mercury, zinc, and iron with carbonate of lime and silica; in a vehicle containing benzine, resin and linseed oil.

Paint B.

Anticorrosive: Oxides of zinc and iron, calcium carbonate, and silica; in a vehicle containing benzine, resin and linseed oil.

Antifouling (a): Oxides of mercury, zinc and iron with silica; in a vehicle containing zinc soap, tar, resin, linseed oil and benzine.

Antifouling (b): Cuprous oxide, mercuric oxide and arsenic sulphide; in a vehicle containing varnish resins, benzine and nitrobenzol.

Paint C.

Anticorrosive: Iron oxide, with a silicious earth similar to kaolin, and small quantities of aluminum, magnesium oxides; in a vehicle containing a mixture of benzol and coal tar naphtha with resin and zinc soap.

Antifouling: A mixture of silicious earth similar to kaolin, with iron oxide and oxides of copper and mercury; in a vehicle containing coal tar naphtha and benzol with resin, copper soap and zinc soap.

Paint D.

Anticorrosive: Iron oxide earth and silicious matter similar to china clay, with a small percentage of zinc oxide; in a vehicle containing coal tar naphtha and light petroleum hydrocarbons with resin and small amounts of zinc soaps.

Antifouling: Iron oxide earth, silicious matter similar to china clay, cuprous oxide and zinc white (is free from mercury); in a vehicle containing coal tar naptha and light petroleum hydrocarbons with resin and small amounts of zinc soaps.

Paint E.

Anticorrosive: Iron oxide earth, zinc white, silicious matter similar to china clay and cuprous oxide; in a vehicle of coal tar naphtha with resin and zinc linoleate.

Antifouling: Iron oxide earth, zinc oxide, cuprous oxide, graphite and silicious matter similar to talc; in a vehicle of coal tar naphtha, resin and zinc soap.

Paint F.

Anticorrosive: Oxides of iron and zinc, silica, alumina and lime; in a vehicle of linseed oil and a volatile hydrocarbon.

Antifouling: Iron, zinc and copper oxides, silica, alumina and lime; in a vehicle containing tar oil, turpentine and wood spirit.

Paint G.

Anticorrosive: Metallic brown; in a vehicle of linseed oil, wood tar, wood alcohol and resins.

Antifouling: Oxides of copper, mercury and iron, with calcium sulphate; in a vehicle containing copper and mercury soaps, linseed oil and benzine.

Paint H.

Anticorrosive: Oxides of iron and manganese with lime; in a vehicle containing linseed oil, hydrocarbons and nitro-benzol.

Antifouling: A green copper soap containing about 9% of copper oxide.

Paint I.

Anticorrosive: Metallic brown (containing about 56% of iron oxide); in a vehicle containing zinc soap, benzine, aniline oil, tar and resins.

Antifouling green: About 90% of Paris green (copper aceto-arsenic) and about 10% of calomel; in a vehicle of lead soap, aniline oil and a thick resin varnish.

It should be noted that paints H and I are of the type of so-called soap or grease paints and are applied hot.

Action of Ship's Bottom Paints.

There is a question as to the exact nature of the action of antifouling paints in preventing marine growths. The most probable explanation appears to be that in the case of the poison paints the spores are killed by the soluble chlorides formed by the action of sea-water on the "poison" before they are able to attach themselves. Dead barnacles often are seen attached to the bottom of ships, and often there are evidences that others have dropped off; it appears likely, however, that this is not due to the action of the paint but to other causes, presumably the water in which the ships have been lying before being docked. In the case of the grease paints, the familiar exfoliation theory is generally advanced. That does not appear tenable, as the characteristics of the paint are not such as to support it, even if we do admit that it is correct in the case of copper sheathing. It seems likely that these paints, due to their softness and slippery surface, simply render the attachment of growths difficult. In any event, the popularity of this class of paints has decreased considerably, due in a measure probably to the high cost of applying them.

There is an undoubted variation in the efficiency of paints, depending on the waters, the season of the year, etc. A paint that may give excellent results at one time, may, in other waters or at other seasons in the same waters, fail entirely to protect from fouling. Furthermore, there is a difference in result, due to conditions not understood which make the barnacle crop vary from year to year. The apparent results are affected frequently by the vessel's stay at the dockyard prior to docking, as the water may be fresh, as at Philadelphia, or it may contain foreign substances, as at New York, in both of which cases the barnacles die and frequently fall off.

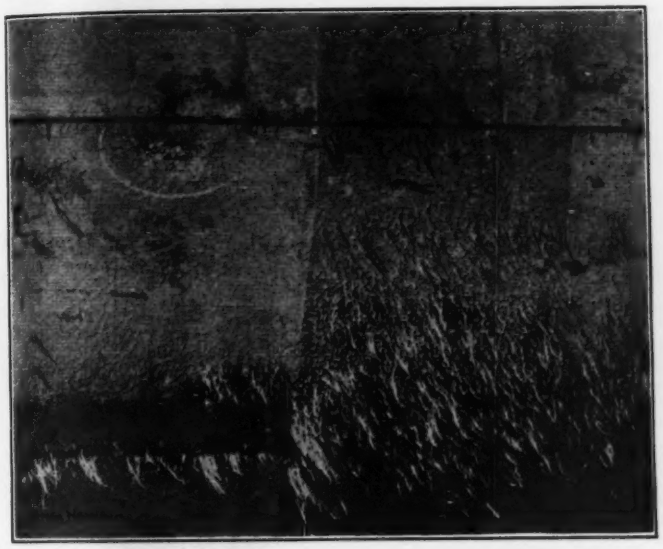
USE OF BOTTOM PAINTS IN U. S. NAVY.—Since the 1900 edition, the Navy Regulations have required that, wherever practicable, paint of the same nature as that previously used shall be employed on the bottom of naval vessels. This requirement was based on the idea, which appears to be to some extent erroneous, that different kinds of paint of differing compositions affect each other deleteriously, and that the best results can be obtained only when different kinds are not used on the same bottom. This idea was so firmly fixed that this provision of the regulations was interpreted by one Secretary of the Navy to require that the same brand should be used wherever practicable, and instructions to this end were issued to the paint boards at all navy yards. This resulted in requiring the purchase, at manufacturers' own prices named without competition, of the necessary supplies of various brands of ship-bottom paints. It was left to the shipbuilder to apply any one of the approved brands of paint to the bottom of a vessel building under contract, and the subsequent use of whatever brand he chose became in this way imposed to some extent on the Navy Department. The conditions resulting from this practice became intolerable, as the prices paid for supplies of ship's bottom paint purchased without competition were excessive, and manufacturers of other ship's bottom paints than those commonly approved and used became insistent in their demands for recognition and to be given a chance to compete for the ship's bottom paint contracts.

Realization of the undesirable features of these conditions and the wish to remedy them, coupled with the information that patent rights on certain proprietary formulas for ship's bottom paints had expired and thus become public property, led the department to the decision in 1906 to experiment in the development and manufacture at a navy yard of a suitable ship's bottom paint for naval purposes. With this in view, experiments were undertaken simultaneously at the navy yards, Norfolk and New York; and a vast amount of work was done in experimentation on various compositions.

The Norfolk Paint.

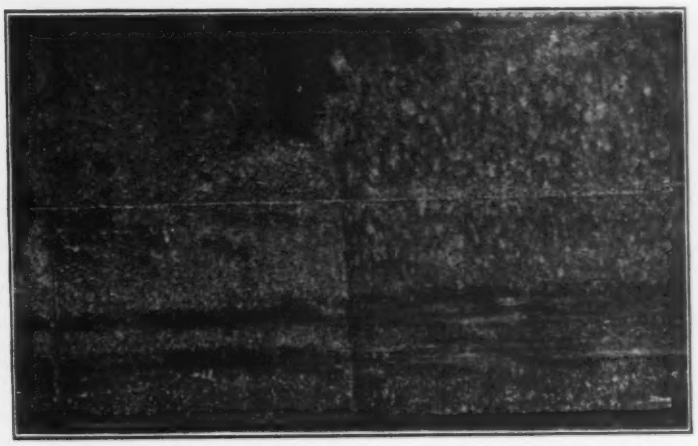
At Norfolk a number of formulas were developed, most of them involving the use of a varnish vehicle made with alcohol and shellac. These were tested out primarily by application to steel plates for submergence along the water front. Those which gave the best results in this test were tested further by being applied in patches to the bottom of several coal barges, along with one or more of the standard proprietary brands, to determine whether the results obtained from the paints under test were comparable with those that would be obtained from the paints previously used. In this manner, by a process of elimination, the formula for the most efficient ship's bottom paint was selected from the large number that were tried. The bottom of a collier was then painted with this paint and, the result obtained proving satisfactory, it was decided to apply paint of this composition to portions of the bottoms of two of the battleships that were then about to start on the cruise around the world with the fleet.

It is a general rule of the Navy Department in applying two kinds of ship's bottom paints to the bottom of a vessel for comparison, to divide the bottom into four quarters, each of the kinds of paint being applied to the forward quarter on one side and the after quarter on the other side. This is to ensure that both paints will be



Left half painted with Norfolk paint. Right half painted with a standard brand commercial paint.

FIG. 1. COMPARISON OF PAINTS ON BOTTOM OF A NAVY-YARD TUG.



Left half painted with a commercial standard paint. Right half painted with Norfolk paint.

FIG. 2. COMPARISON OF PAINTS ON BOTTOM OF A BATTLESHIP.

subjected to the same conditions, as frequently one side is more exposed to fouling or corrosion than the other.

The Norfolk paint was applied in this manner to one-half of each side of the U. S. S. "Minnesota" and the U. S. S. "Kentucky," the other half of each being painted with the proprietary paint which had been applied previously to each vessel. In this way, a direct comparative test of the quality of the Norfolk paint was obtained with two approved brands of proprietary paint. At the docking of the vessels on the west coast, the condition of the portions coated with the Norfolk paint was found to be most satisfactory and compared favorably with the portions covered by the proprietary paints, as well as with the condition of the bottoms of other vessels of the fleet. Later the comparative experiments were extended to 16 other battleships. The Norfolk paint was found to give results quite as good and in many cases better than the proprietary paints with which it was in comparison and, with this in view, the Department ordered the still further extension of the use of the government paint. Continued good reports being received as to the results from the Norfolk paint, at the fall docking in 1910, the Department directed the discontinuance of comparative tests of the character referred to, except in such special cases as might arise from time to time. This action amounted in effect to the adoption for general use on naval vessels of the ship's bottom paint developed and largely manufactured at the Norfolk Navy Yard. At the present time, practically all naval vessels have their bottoms so painted.

COMPOSITION AND CHARACTERISTICS. — As has been noted, the paint consists of a varnish vehicle of shellac in alcohol, with the addition of small percentages of turpentine and pine-tar oil. The pigment for the anticorrosive consists of dry metallic zinc dust and dry white zinc oxide:

FORMULA FOR 10 GALS. ANTICORROSIVE PAINT.

7¼	gals. grain alcohol.
7 9/10	lbs. gum shellac.
5/8	gal. turpentine.
5/8	gal. pine-tar oil.
9½	lbs. metallic zinc, dry.
28½	lbs. white zinc oxide, dry.

The pigment for the antifouling consists of dry white zinc oxide, Indian red and red oxide of mercury:

FORMULA FOR 10 GALS. ANTIFOULING PAINT.

6	gals. grain alcohol.
13¾	lbs. gum shellac.
1	gal. pine-tar oil.
1	gal. turpentine.
13¾	lbs. white zinc oxide, dry.
13¾	lbs. Indian red.
4¾	lbs. red oxide of mercury, dry.

In mixing the paint in quantities, the requisite amounts of alcohol and shellac are dumped into the shellac cutter and the cutter turned for about four hours, and allowed to stand over night. The mixture is then drawn into large change tanks and the other liquids added. The dry ingredients are mixed separately and ground through the paint mills with a small quantity of the liquids and the mixture is added to the bulk of the liquid vehicle in the change tank and stirred to ensure thorough mixing. The paint is put into 10-gal. steel drums and each full drum is weighed to assure that the proper amount of paint is contained. The drums are sealed carefully to prevent loss by evaporation of the alcohol.

The anticorrosive paint resulting is of a light gray color, somewhat thin. The antifouling paint is thicker and of a dark red color. In both of these paints the pigment has a tendency to settle, and for that reason care must be taken to ensure the thorough stirring of the paint before use. Due to the affinity of alcohol for water and to the fact that its addition to the paint causes the shellac to precipitate, great care must be exercised to prevent water from getting into the drums or paint buckets. If the bottom of the ship is very wet, it is necessary that free water be wiped off before applying the paint.

Before the paint is applied to the bottom of a vessel, all fouling matter and loose paint should be removed. Old paint that adheres need not be removed, except that if grease paints have been used all such paint must be removed, as the Norfolk paint will not adhere to it.

COST.—The cost of production of the Norfolk paint is fixed by the cost of the raw ingredients, which is subject to some variation. For example, the shellac has varied from 14 cts. per lb. to 17¾ cts., the price on the last annual contract which covered 500,000 lbs. Similarly, the cost of the alcohol, which is obtained tax-free, varies somewhat, the price averaging about 35 cts. per gal. The other ingredients vary in price but little. The 10-gal. drums cost about $1.50 each and can be manufactured at the Norfolk yard at considerably less cost than if purchased. They can be used repeatedly, so that their cost is distributed over a number of gallons of paint. The labor charges for the manufacture of the paint do not exceed 3½ cts. per gal.

Estimates made in 1910 of the cost of paint for the bottoms of all vessels on the navy list, using the kinds of proprietary brands of paint that were purchased usually prior to 1908 and distributed among the ships in the proportions of each brand then customary and at the prices then current, show that the cost of the paint for a single painting of the bottoms of all vessels of the navy, not including coal barges, etc., under the conditions noted, would have been somewhat more than $100,000. The cost of an equal amount of the Norfolk ship's bottom paint at the prevailing cost of manufacture would be less than $33,000. As a majority of the vessels of the navy are painted twice a year, it will be seen that the annual saving to the government by this means at the present time is probably not less than $100,000 annually. It should be noted, however, that largely as a result of the government entering the field with its own paint the prices asked for ship's bottom paint by various firms previously supplying the navy have been so reduced that if, for expediency or some other reason, the Navy Department decided in the future to purchase all or a portion of its ship's bottom paint, there still would remain an appreciable saving to be credited to the Norfolk paint.

The capacity of the plant at the navy yard, Norfolk, is not less than 500 gals. per day of 8 hrs., or 1,500 gals. if working in three shifts. So far, no other yard, except Cavite, has been authorized to manufacture this paint, but, in case of necessity, there is nothing to prevent any of the large navy yards from doing so.

This paint is manufactured and successfully used at the naval station, Cavite, and considerable advantage has been derived from this fact, in rendering unnecessary the shipment at periodic intervals of large quantities of ship-bottom paint, which, when stored, is subject to deterioration. The use of the Norfolk paint on vessels in these waters has been attended with uniform success, a report received in November, 1910, stating that the Norfolk paint had given better results than any other kind of ship's bottom paint tried. As those waters cause considerable fouling, it is obviously of great advantage to use an efficient bottom paint. The facilities for the manufacture of the paint at Cavite are good, and the output can be made as high as 1,000 gals. a day. This, combined with the capacity of the floating dry dock "Dewey" for rapid docking of vessels, would render possible the prompt docking of a fleet in these waters in cases of emergency. Similar satisfactory results have been obtained in the waters at Honolulu, which are well known to cause excessive fouling.

Col. Jackson Ellsworth Sickels.

Col. Jackson Ellsworth Sickels, who died in Washington, D. C., on June 18, at the age of 83 years, while little known to engineers of the present generation, was a prominent figure in the group of pioneer railway builders which carried civilization to the Western plains in the years following the Civil War.

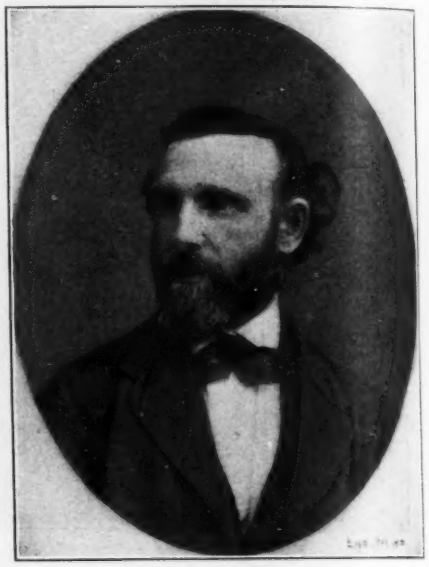
Col. Sickels was a descendant of a titled Austrian family which settled in this country about 1665. In that year the first American Sickels was a soldier in the garrison of Fort Orange, the early Dutch settlement on the banks of the Hudson River which became the city of Albany, N. Y. Four generations later came Johannus Sickels of Bergen Point, N. J., who invented a cloth-cutting machine notable in its day. His son, Dr. John Sickels, a physician of Philadelphia, was the father of Col. Sickels and his noted brothers Gen. Theophilus E. Sickels and Frederick E. Sickels. Their mother was Hester Ann Ellsworth Sickels, a niece of Oliver Ellsworth, Chief Justice of the United States in Washington's Administration.

These three brothers all became widely known for their general accomplishments in the field of engineering. Theophilus E. Sickels was active in the early history of the Union Pacific Ry. and held the positions of Chief Engineer and General Superintendent. He was engineer of the Omaha Bridge, famous as the first bridge over a Western river where pneumatic caissons were used in making the foundations. He was a prominent member of the American Society of Civil Engineers, joining the Society in 1872, when it was in its formative stage.

Frederick E. Sickels became widely known to mechanical engineers the country over for his invention of the Sickels' cut-off valve, one of the greatest steps in the development of the steam engine. It has been claimed that it was with the aid of Sickels' ideas that George H. Corliss, a fellow apprentice in the Allaire shops originated the Corliss valve gear. Besides the trip-valve, Sickels also invented many other improvements to the steam engine and a steam operated steering gear for ships. He was also a member of the American Society of Civil Engineers, and he died in 1895.

The only surviving member of the family is David Banks Sickels, a well-known author and lecturer of New York City, who was at one time United States Minister to Siam.

Col. Jackson Ellsworth Sickels, whose recent death is noted above, was born in Philadelphia. While still a very young man he was given command of a New York regiment and saw active service at the beginning of the Civil War. His ability as an engineer, however, soon brought him into that branch of the service, and he was placed in charge of construction of fortifications, military roads and bridges in Virginia and of defenses for the city of Washington. At the close of the war he settled in Alexandria, Va., and married there a Southern lady, Miss Antonia P. Frazier, who survives him.



J. E. Sickels

He continued to follow engineering work for many years. He was appointed by President Grant to investigate and report on levee work at the mouth of the Mississippi River, and had charge of the work of strengthening the foundations of Washington Monument, in the city of Washington. For several years he was associated with his brother, Theophilus Sickels, in the construction of the Union Pacific Ry. Following this he spent many years in locating and constructing railways in various parts of this country and Canada. As Resident, District and Chief Engineer he had charge of construction of over 1,200 miles of railway track, and he surveyed many other lines which were not built.

During all these years, Alexandria remained his permanent home, and there he retired when the active period of his life was over. For many years he was County Surveyor of Alexandria County, and was a highly esteemed citizen.

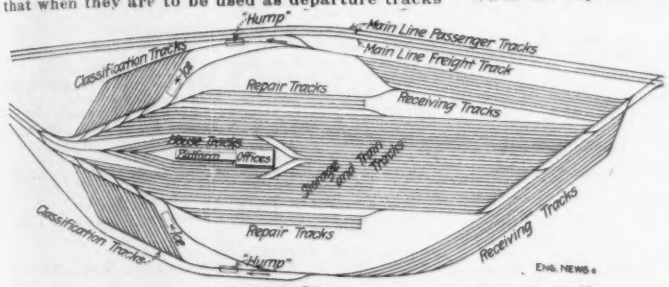
Besides his widow and brother he leaves one daughter, Mrs. H. P. Carter, of Alexandria.

A Proposed Modification in Railway Freight Yard Design.

The general principle of the design of railway freight yards so far as the car switching service is concerned, is to provide for (1) receiving inbound trains, (2) classifying or grouping the cars of these trains into such arrangement as may be required, and then (3) putting these groups together to form outbound local, through or fast-freight trains. The work is done usually by means of three groups of tracks, each known as a yard, and termed respectively, the receiving, classification and departure yards. In some cases the classification yard serves also as the departure yard. Auxiliary to these yards is a storage yard for cars awaiting orders. The classification may be by commodities or by destinations, or otherwise; thus all cars containing the same commodity or destined for the same division or station are placed upon individual tracks.

In most cases, the classification tracks are of considerable length, which necessarily involves long movements in selecting particular cars for the trains or for the storage yard. If this yard is used also as a departure yard, the tracks must necessarily be of sufficient length to hold a train of standard length, but otherwise this is not necessary; in the latter case a half-train length has been recommended. The "Manual" of the American Railway Engineering Association contains the following note on this point:

> No definite recommendation can be made as to length or number of classification tracks, except that when they are to be used as departure tracks they should be long enough to hold full trains, and that when conditions permit there should be as many tracks as can be used to advantage to avoid subsequent classification and consequent delay.



A PROPOSED TYPE OF FREIGHT YARD HAVING GROUPS OF SEVERAL SHORT TRACKS FOR THE CLASSIFICATION WORK.
(James Rollo, Chicago; Designer.)

To facilitate the classification work and movements, "gridirons" composed of short parallel tracks connected at each end by a lead track have been used in Europe for a number of years. This principle has been embodied in a new type of freight yard, in which a "gridiron" of several short tracks takes the place of the usual arrangement of fewer and longer tracks. This is shown in the accompanying cut, which represents a typical plan only. The form of yard has been patented by Mr. James Rollo, 6954 Yale Ave., Chicago, but we are informed that this has been done only to protect the design, and that its use will be permitted readily to railways desiring to introduce it. The plan provides for gravity switching (though it is applicable also to level yards), and it will be seen that cars descending the incline from the "hump" or summit are diverted to a gridiron of short classification tracks; the length of the tracks is not to exceed 500 ft. (for ten cars). From the lower end of these tracks the cars are taken as required and placed in the required order upon the departure or storage tracks.

The classification and storage or train tracks are in close conjunction, so that the switching movements are relatively short. Further, the two groups of classification tracks (for both directions of train movements) are placed at the same end of the yard, which, according to the inventor, makes it possible for one engine to assemble the cars that two engines classify. Another feature of the plan is the location of a freight transfer house in the middle of the yard, with tracks so arranged as to facilitate the supply of empty cars for the transfer loads. Advantages claimed for this plan are: (1) The elimination of re-switching, (2) freedom from blockades, (3) rapidity and safety of switching, (4) freedom from injury to the switch or yard men, (5) reduction in cost of yard work or storage tracks. An apparent defect in the plan (but which is quite independent of the classification feature) is the great length of storage tracks; this would make it difficult to get one car for which forwarding orders are received. With such long storage tracks there is a tendency to let cars remain until some convenient time, owing to the time and trouble involved in getting them out and putting them into trains.

The use of short classification tracks and gridirons (and with gridirons in duplicate) was suggested by the Yards and Terminals Committee of the Railway Engineering Association in its report of 1901. This report outlined the use of four separate yards or groups of tracks for the switching service: (1) the receiving yard, to receive inbound trains complete; (2) the separating yard, where the cars from these trains are distributed by districts or commodities; (3) the classification yard, to complete this distribution, and (4) the departure yard where the cars are made up into outbound trains. From this report we quote the following description of the work, and call particular attention to the suggested "gridirons" with tracks long enough only for six cars.

> CLASSIFICATION YARD.—Here the second distribution or assorting of the cars is effected. When the separation in the preceding yard [separating yard] is by districts, the purpose of the classification yard is to put the cars of the different districts in regular order. Thus the cars of each district (already placed on one of the tracks of the separating yard) are switched in the classification yard in order required for delivery at destination. When the separation is by commodities, the cars of each commodity (already placed on one of the tracks of the separating yard) are further assorted by classes or grades. Thus all the cars of grain, placed indiscriminately on a track in the separating yard, will be rearranged in the classification yard so that the cars of wheat, corn, oats, etc., are each grouped on separate tracks. The classification yards should be located in advance of the separating yard, and in such a way that cars may readily be moved into it from any of the tracks in the latter yard. It is usually in the form of a gridiron, and its capacity will be determined by the number of cars going to a district, with ample allowance for an excess number or for emergencies. As an example: With 36 cars going to a district, two "gridirons" of six tracks each with a capacity of six cars to a track, will give such control of the entire set of cars that it can be turned end for end, or car for car. This type of yard may be made up of a series of parallel stub tracks instead of gridirons; such an arrangement is sometimes termed a lancing yard.

We believe that no such arrangement has been used in this country, however, the general tendency in yard design being to increase the capacity by increasing the length of tracks. In most cases the separating yard is omitted, and in some cases the classification yard is made to do double duty as a departure yard also. The arrangement in any one case will depend largely upon two factors: (1) the situation as to topography and right-of-way; (2) the character of the traffic and of the work to be done, as this may differ materially in matters of both general and detail requirement. The necessity of greater facility in classification work was referred to again by the above mentioned committee in its report of 1906, as noted below. This was in regard to gravity switching, but the suggestion of a second hump (presumably feeding the cars to a second gridiron) was not regarded favorably.

The Engineering and Technical Societies of the United States and Canada.

A list of the important engineering societies of the United States and Canada was published in Engineering News, June 21, 1906, in response to numerous requests for information about these societies. Recently inquiries have again been coming in—so many of them, in fact, as to suggest the desirability of republishing the complete list, corrected and revised to date.

The card index maintained in the office of this journal has been kept up during the five years since the publication of the previous list, so far as concerns the more important societies whose proceedings are regularly noted in Engineering News; but in order to obtain accurate and fresh information, especially as to the number of members of each society, a special letter has been sent to each secretary. Replies were received from practically all the societies included in the present list.

It will be noticed at once that many associations are listed which are not strictly, or exclusively, engineering societies. The aim has been to include the chief societies in which readers of this journal would be interested. Certain large classes of societies, such, for example, as the student's engineering societies in the technical schools and the local branches of the great national societies, have been omitted through lack of space.

In comparing the present directory with that of five years ago, perhaps the most noticeable general change is the increase in the number of State engineering societies and of sanitary engineering and water-supply associations. Besides these, among the more important new societies are the American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Metallurgical Society, American Society of Agricultural Engineers, American Society of Engineering Contractors, International Railway Fuel Association, Inventors' Guild, and the Mining and Metallurgical Society of America.

To offset these new additions to the list, a considerable number of the societies listed five years ago have become defunct; but these were mainly organizations of no great importance, from an engineer's viewpoint.

It was decided to omit in the present list the names of society presidents, for the reason that in most cases this information would be out of date within twelve months or less from the time of publication. The office of secretary, on the contrary, is generally a more permanent position. In many cases, the secretaries given in the list of five years ago are still in office.

An effort has been made in preparing the present list to obtain the number of members of each society. There are comparatively few cases where the membership is not given, and in the majority of these it is because their secretaries have refused or neglected to give information on this point. The growth of the four principal national engineering societies is of particular interest:

	Number of members.		Growth in 5 years.
	1906.	1911.	
American Institute of Electrical Engineers	3,594	7,118	3,524
American Society of Civil Engineers	3,569	5,976	2,407
American Institute of Mining Engineers	3,886	4,200	314
American Society of Mechanical Engineers	2,929	3,899	970

The society showing the most remarkable growth is the National Electric Light Association, whose membership has increased by about 1,000 during the past two or three months. It had 923 members in 1906, and has now over 9,000.

At first thought it would appear to be a simple matter to arrange the societies in classes and subdivisions according to their nature and work; but this would lead unavoidably to considerable duplication, or cross reference. Three general classes, however, are fairly distinct, viz.: national, State or district, and local societies. In the following list, the societies are grouped alphabetically under these three heads:

Engineering and Technical Societies of the United States and Canada.

National Societies.

Air Brake Association.
Secy., F. M. Nellis, 53 State St., Boston, Mass.
1,100 members.

American Association for the Advancement of Science.
Permanent Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.
8,000 members.

American Association for Highway Improvement.
Secy., J. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.
6,225 members.

American Association of Manufacturers of Sand-Lime Products.
Secy., W. E. Plummer, Jr., 211 Fillmore Ave., Buffalo, N. Y.
30 members.

American Association of Railroad Superintendents.
Secy., O. G. Fetter, 101 Carew Bldg., Cincinnati, Ohio.
87 (railroads) members.

American Association of Refrigeration.
Secy., J. F. Nickerson, 431 So. Dearborn St., Chicago, Ill.
621 members.

American Boiler Manufacturers' Association.
Secy., J. D. Farasey, Cleveland, Ohio.
108 members.

American Ceramic Society.
Secy., Edward Orton, Jr., Ohio State University, Columbus, Ohio.
424 members.

American Chemical Society.
Secy., Charles L. Parsons, Durham, N. H.
5,400 members.

American Civic Association.
Secy., Richard B. Watrous, 913 Union Trust Bldg., Washington, D. C.
2,800 members.

American Economic Association.
Secy., T. N. Carver, Harvard University, Cambridge, Mass.
2,000 members.

American Electric Railway Association.
Secy., H. S. Donecker, 29 West 39th St., New York City.
1,528 members.

American Electrochemical Society.
Secy., Jos. W. Richards. Lehigh University, South Bethlehem, Pa.
1,293 members.

American Forestry Association.
Secy., Edwin A. Start, 1410 H St., N. W., Washington. D. C.
6,000 members (approximately).

American Foundry Foremen.
Secy., Hugh McPhee, Tarrytown, N. Y.
370 members.

American Foundrymen's Association.
Secy., Richard Moldenke, Watchung, N. J.
716 members.

American Gas Institute.
Secy., A. B. Beadle, 29 W. 39th St., New York City.
1,420 members.

American Hardware Manufacturers' Association.
Secy., F. D. Mitchell, 309 Broadway, New York City.
270 members.

American Highway League.
Secy., T. H. MacDonald, State Highway Engineer, Ames, Ia.

American Institute of Architects.
Secy., Glenn Brown, The Octagon, Washington, D. C.
1,042 members.

American Institute of Chemical Engineers.
Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.
150 members.

American Institute of Consulting Engineers.
Secy., E. W. Stern, 103 Park Ave., New York City.
38 members.

American Institute of Electrical Engineers.
Secy., Ralph W. Pope,* 33 West 39th St., New York City.
7,118 members.

American Institute of Mining Engineers.
Secy., Joseph Struthers, 29 West 39th St., New York City.
4,200 members.

American Iron and Steel Association.
Vice-Pres. and Gen. Mgr., James M. Swank, 261 South 4th St., Philadelphia, Pa.
200 members (companies and corporations).

American Iron and Steel Institute.
Secy., James T. McCleary, 30 Church St., New York City.
315 members.

American Mathematical Society.
Secy., F. N. Cole, 501 West 116th St., New York City.
650 members.

American Metallurgical Society.
Secy., R. Stuart Browne, 61 Fremont St., San Francisco, Cal.

American Mining Congress.
Secy., J. F. Calbreath, Jr., Denver, Colo.
1,500 members.

American Museum of Safety.
Director, W. H. Tolman, 29 West 39th St., New York City.
100 members.

American Peat Society.
Secy., Julius Bordollo, Kingsbridge, New York City.
193 members.

American Public Health Association.
Secy., W. C. Woodward, Washington, D. C.
810 members.

American Railway Association,
General Secy., W. F. Allen, 30 Vesey St., New York City.
432 members (railway companies operating 259,034 miles of road).

American Railway Bridge and Building Association.
Secy., C. A. Lichty, 715 Jackson Blvd., Chicago, Ill.
450 members.

*Resigned recently to become Honorary Secretary.

American Railway Engineering Association.
Secy., E. H. Fritch, 962 Monadnock Blk., Chicago, Ill.
990 members.

American Railway Master Mechanics' Association.
Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.
1,000 members.

American Road Builders' Association.
Secy., E. L. Powers, 150 Nassau St., New York City.

American Society for Testing Materials.
Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.
1,350 members.

American Society of Agricultural Engineers.
Secy., J. B. Davidson, Iowa State College, Ames, Ia.
55 members.

American Society of Civil Engineers.
Secy., Charles Warren Hunt, 220 West 57th st., New York City.
5,976 members.

American Society of Engineering Contractors.
Secy., J. R. Wemlinger, 623 Park Row Bldg., New York City.
800 members.

American Society of Engineer Draftsmen.
Secy., Henry L. Sloan, 116 Nassau St., New York City.

American Society of Heating and Ventilating Engineers.
Secy., W. W. Macon, 29 West 39th St., New York City.
400 members.

American Society of Inspectors of Plumbing and Sanitary Engineers.
Secy., Thos. J. Claffy, Asst. Chief Sanitary Inspector, Chicago, Ill.

American Society of Mechanical Engineers.
Secy., Calvin W. Rice, 29 West 39th St., New York City.
3,899 members (not including 146 affiliates and 665 student members).

American Society of Municipal Improvement.
Secy., A. P. Folwell, 239 West 39th St., New York City
350 members.

American Society of Naval Engineers.
Secy., Commander U. T. Holmes, Navy Dept., Washington, D. C.
1,133 members.

American Society of Refrigerating Engineers.
Secy., Wm. H. Ross., 154 Nassau St., New York City.
250 members.

American Society of Supervising Iron Erectors.
Secy., T. H. Kennington, 328a Monroe St., Brooklyn. N. Y.
108 members.

American Society of Swedish Engineers.
Secy., I. Oesterblom, 271 Hicks St., Brooklyn, N. Y.
267 members.

American Supply and Machinery Manufacturers Association.
Secy., F. D. Mitchell, 309 Broadway, New York City.
193 members.

American Water Works Association.
Secy., J. M. Diven, 14 George St., Charleston, S. C.
939 members.

Architectural League of America.
Secy., H. S. McAllister, 1517 H St., N. W., Washington, D. C.
2,000 members.

Association of American Portland Cement Manufacturers.
Secy., Percy H. Wilson, 1,330 Land Title Bldg., Philadelphia, Pa.

Association of American State Geologists.
Secy., Frank W. DeWolf, Urbana, Ill.
36 members.

Association of Edison Illuminating Companies.
Secy, N. T. Wilcox, Lowell, Mass.
72 (companies) members.

Association of Engineering Societies.
Secy., Fred Brooks, 31 Milk St., Boston, Mass.
8 (societies—aggregate membership, 2,000) members.

Association of Ry. Telegraph Superintendents.
Secy., P. W. Drew, Soo Line, Chicago, Ill.
185 members.

Association for Standardizing Paving Specifications.
Secy., J. B. Hittell, Chief Engineer of Streets, City Hall, Chicago, Ill.
42 (cities) members.

Association of Transportation and Car Accounting Officers.
Secy., G. P. Conrad, 25 Church St., New York City.
403 members.

Canadian Cement and Concrete Association.
Secy., W. Snaith, 57 Adelaide St. East, Toronto, Ont.
200 members (approximately).

Canadian Electrical Association.
Secy., T. S. Young, 220 King St. West, Toronto, Ont.
500 members.

Canadian Mining Institute.
Secy., H. Mortimer Lamb, Rooms 3 & 4, Windsor Hotel, Montreal, Que.
1,004 members.

Canadian Railway Club.
Secy., Jas. Powell, P. O. Box 7, St. Lambert, near Montreal, Que.
710 members.

Canadian Society of Civil Engineers.
Secy., C. H. McLeod, 413 Dorchester St., W., Montreal, Que.
2,750 members.

Canadian Society of Forest Engineers.
Secy., F. W. H. Jacombe, Dept. of the Interior, Ottawa.
25 members.

Canadian Street Railway Association.
Secy., Acton Burrows, 70 Bond St., Toronto, Ont.

Chemists' Club.
Secy., Arthur E. Hill, 52 East 41st St., New York City.
795 members.

Foundry and Machine Exhibition Co.
Secy., C. E. Hoyt, Lewis Institute Bldg., Chicago, Ill.
120 members.

Franklin Institute.
Secy., R. B. Owens, 15 S. Seventh St., Philadelphia, Pa.
1,170 members.

Geological Society of America.
Secy., Edmund Otis Hovey, Care American Museum of Natural History, New York City.
339 members.

Illuminating Engineering Society.
Secy., P. S. Millar, 25 W. 39th St., New York City.
1,600 members (approximately).

Industrial Safety Association.
Asst. Secy., M. S. Hutton, 29 W. 39th St., New York City.
168 members.

Institute of Operating Engineers.
Secy., Hubert E. Collins, 29 W. 39th St., New York City.
326 members.

International Acetylene Association.
Secy., A. Cressy Morrison, Peoples Gas Bldg., Chicago, Ill.
157 members.

International Association for the Prevention of Smoke.
Secy., R. C. Harris, City Hall, Toronto, Ont.
176 members.

International Association of Fire Engineers.
Secy., James McFall, Roanoke, Va.
843 members.

International Association of Municipal Electricians.
Sec., Clarence R. George, Houston, Tex.
118 members.

International Congress of Inventors.
Secy., R. T. Olcott, 39 State St., Rochester, N. Y.
876 members.

International Master Boilermakers' Association.
Secy., H. D. Vought, 95 Liberty St., New York City
317 members.

International Railway Fuel Association.
Secy., D. B. Sebastian, La Salle Station, Chicago, Ill.
400 members.

International Railway General Foremen's Association.
Secy., H. L. Bryan, Box 666, Two Harbors, Minn.

International Railroad Master Blacksmiths' Association
Secy., A. L. Woodworth, Lima, O.
325 members.

International Society of State and Municipal Building Commissioners and Inspectors.
Executive Officer, F. W. Fitzpatrick, 4200 16th St., Washington, D. C.
212 members.

Inventors' Guild.
Secy., Thos. Robins, 13 Park Row, New York City.
30 members.

League of American Municipalities.
Secy., John MacVicar, Des Moines, Iowa.

Maintenance of Way Master Painters' Association.
Secy., H. J. Barkley, Ill. Cent. R. R., Carbondale, Ill.
101 members.

Master Car and Locomotive Painters' Association.
Secy., A. P. Dane, B. & M. R. R., Reading, Mass.
300 members.

Master Car Builders' Association.
Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago.
750 members.

Mining and Metallurgical Society of America.
Secy., W. R. Ingalls, 505 Pearl St., New York City.
200 members.

National Association of Cement Users.
Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Pa.
1,140 members.

National Association of Cotton Mfrs.
Secy., C. J. H. Woodbury, 45 Milk St., Room 501, Boston, Mass.
1,100 members.

National Association of German-American Technologists.
Secy., K. Kaelble, 29 West 39th St., New York City.
790 members.

National Association Master Gravel and Slag Roofers of America.
Secy., L. P. Sibley, Whitehall Bldg., New York City.
160 members.

National Association of Manufacturers of the U. S. A.
Secy., Geo. S. Boudinot, 30 Church St., New York City.
4,000 members.

National Association of Master Plumbers.
Secy., Samuel F. Wilson, 56 So. Arlington Ave., East Orange, N. J.
9,000 members.

National Association of Railway Commissioners.
Secy., Wm. H. Connolly, Interstate Commerce Commission, Washington, D. C.
225 members.

National Association of Stationary Engineers.
Secy., F. W. Raven, 443 So. Dearborn St., Chicago, Ill.
20,000 members.

National Brick Manufacturers' Association.
Secy., T. A. Randall, Indianapolis, Ind.
650 members.

National District Heating Association.
Secy., D. L. Gaskill, Greenville, Ohio.
170 members.

National Electric Light Association.
Secy., T. C. Martin, 29 West 39th St., New York City
9,214 members.

National Electrical Contractors' Association of the United States.
Secy., W. H. Morton, 41 Martin Bldg., Utica, N. Y.
886 members.

National Fire Protection Association.
Secy., Franklin H. Wentworth, 87 Milk St., Boston.
1,955 members.

National Founders' Association.
Secy., F. W. Hutchings, 915 Hammond Bldg., Detroit, Mich.
500 members.

National Good Roads' Association.
Secy., Anna M. Grady, Hotel La Salle, Chicago, Ill.
2,000 members.

National Hardware Association of the United States.
Secy., T. Jas. Fernley, 505 Arch St., Philadelphia, Pa.
220 members.

National Irrigation Congress.
Secy., Arthur Hooker, Chicago, Ill.

National Lime Manufacturers' Association.
Secy., Fred K. Irvine, 355 Dearborn St., Chicago, Ill.
900 members (approximately).

National Machine Tool Builders' Association.
Secy., C. E. Hildreth, Worcester, Mass.
150 members.

National Municipal League.
Secy., Clinton Rogers Woodruff, North American Bldg., Philadelphia, Pa.
2,328 members.

National Paving Brick Manufacturers' Association.
Secy., William P. Blair, B. of L. E. Bldg., Cleveland, Ohio.
65 members.
National Rivers and Harbors Congress, U. S. A.
J. F. Ellison, Secy., Cincinnati, Ohio.
9,823 members.
National Society for the Promotion of Industrial Education.
Secy., Edward H. Reisner, 20 West 44th St., New York City.
1,200 members.
National Supply and Machinery Dealers' Association.
Secy., Thos. A. Fernley, 505 Arch St., Philadelphia, Pa.
160 members.
Railway Signal Association.
Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Pa.
1,262 members.
Railway Storekeepers' Association.
Secy., J. P. Murphy, Box "C," Collinwood, Ohio.
600 members.
Railway Supply Manufacturers' Association.
Secy., J. D. Conway, 2133 Oliver Bldg., Pittsburg, Pa.
400 to 500 (companies) members.
Roadmasters' and Maintenance of Way Association of America.
Secy., Walter E. Emery, Chief Engineer, P. & P. U. Ry., Peoria, Ill.
500 members.
Signal Appliance Association.
Secy., F. W. Edmunds, 3868 Park av., New York City.
156 members.
Society for the Promotion of Engineering Education.
Secy., H. H. Norris, Cornell University, Ithaca, N. Y.
1,030 members.
Society of Automobile Engineers.
Secy., Coker F. Clarkson, 1451 Broadway, New York City.
786 members.
Society of Chemical Industry, New York Section.
Secy., Parker C. McIlhiney, 7 East 42d St., New York City.
1,006 members.
Society of Naval Architects and Marine Engineers.
Secy., W. J. Baxter, 29 West 39th St., New York City.
843 members.
Technical Publicity Association.
Secy., Fred R. Davis, General Electric Co., Schenectady, N. Y.
115 members.
Traveling Engineers' Association.
Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.
800 members.
Treasury Construction Society.
Secy., T. R. Maul, 4213 Westminster Ave., Philadelphia, Pa.
120 members.
United States Naval Institute.
Secy., P. R. Alger, U. S. N., Annapolis, Md.
845 members.
Water Works Manufacturers' Association.
Secy., Robt. E. Milligan, N. Y. Continental Jewell Filtration Co., 15 Broad St., New York City.
68 members.
Wireless Institute.
Secy., Alfred N. Goldsmith, College of the City of New York, New York City.
50 members.
Wood Preservers' Association.
Secy., F. G. Angier, Room 1073, First National Bank Bldg., Chicago, Ill.

State and District Societies.

Appalachian Engineering Association.
Secy., Dr. H. M. Payne, Morgantown, W. Va.
67 members.
Architectural League of New York.
Secy., Stowe Phelps, 215 West 57th St., New York City.
383 members.
Arkansas Assoc. of Surveyors and Civil Engineers.
Secy., J. O. Jones, Birta, Ark.
64 members.
Arkansas Drainage and Good Roads Assoc.
Secy., Geo. R. Brown, Board of Trade, Little Rock, Ark.
1,000 members.
Association of Ontario Land Surveyors.
Secy., Killaly Gamble, 704 Temple Bldg., Toronto, Ont.
250 members.
Atlantic Deeper Water Ways Association.
Secy., Addison B. Burke, Croxer Bldg., Philadelphia, Pa.
800 members.
Central Electric Railway Association.
Secy., A. L. Neereamer, 308 Traction Terminal Bldg., Indianapolis, Ind.
50 (companies) members.
Central Railway Club.
Secy., H. D. Vought, 95 Liberty St., New York.
700 members.
Colorado Electric Light, Power & Railway Association.
Secy., E. D. Morris, P. O. Box 1052, Colorado Springs, Colo.
110 members.
Connecticut Society of Civil Engineers.
Secy., J. Frederick Jackson, New Haven, Conn.
305 members.
Engineering Association of the South.
Secy., H. H. Trabue, Carnegie Library, Nashville, Tenn.
357 members.
Engineering Society of Wisconsin.
Secy., John C. White, 622 E. Main St., Madison, Wis.
120 members.
Engineers and Architects Association of Southern California.
Secy., H. Z. Osborne, Jr., City Engineer's Office, Los Angeles, Cal.
250 members.
Engineers' Society of Northeastern Pennsylvania.
Secy., H. S. Webb, 1504 Capouse Ave., Scranton, Pa.
276 members.
Engineers' Society of Pennsylvania.
Secy., E. R. Dasher, Gilbert Bldg., Harrisburg, Pa.
740 members.
Engineers' Society of Western New York.
Secy., Helge S. Anderson, 436 Ellicott Sq., Buffalo, N. Y.
30 members.
Engineers' Society of Western Pennsylvania.
Secy., Elmer K. Hiles, 2511 Oliver Bldg., Pittsburg, Pa.
1,000 members (approximately).
Idaho Society of Engineers.
Secy., Edmund M. Blake, Boise, Idaho.
151 members.
Illinois Society of Engineers and Surveyors.
Secy., E. E. R. Tratman, 1138 Monadnock Blk., Chicago, Ill.
231 members.
Illinois Water Supply Association.
Secy., Edward Bartow, Urbana, Ill.
187 members.
Indiana Engineering Society.
Secy., Chas. Brossmann, 43 Union Trust Bldg., Indianapolis, Ind.
210 members.
Indiana Sanitary and Water Supply Association.
Secy., Wm. F. King, Room 24, State House, Indianapolis, Ind.
100 members.
Iowa Engineering Society.
Secy., S. M. Woodward, Iowa City, Iowa.
125 members.
Iowa Street and Interurban Railway Association.
Secy., H. E. Weeks, Davenport, Iowa.
26 members.
Kansas Engineering Society.
Secy., W. S. Gearhart, Kansas State Agricultural College, Manhattan, Kan.
116 members.
Kansas Gas, Water and Electric Association.
Secy., Jas. D. Nicholson, 522 Main St., Newton, Kan.
100 members.
Kansas State Good Roads Association.
Secy., W. S. Gearhart, Kansas State Agricultural College, Manhattan, Kan.
115 members.
Lake Superior Mining Institute.
Secy., A. J. Yungbiuth, Ishpeming, Mich.
507 members.
Louisiana Engineering Society.
Secy., J. M. Robert, Room 6, City Bank & Trust Co., New Orleans, La.
154 members.
Maine Society of Civil Engineers.
Secy., Frank E. Pressey, Bangor, Maine.
119 members.
Massachusetts Electric Lighting Association.
Secy., E. W. Burlett, 84 State St., Boston, Mass.
26 (companies) members.
Michigan Engineering Society.
Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.
235 members.
Michigan Gas Association.
Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.
254 members.
Minneapolis Engineers' Club.
Secy., J. G. Anderson, Warner Bldg., Minneapolis, Minn.
105 members.
Montana Society of Engineers.
Secy., Clinton H. Moore, Butte, Montana.
220 members.
New England Association of Gas Engineers.
Secy. N. W. Gifford, 26 Central Sq., East Boston, Mass.
240 members.
New England Railroad Club.
Secy., Geo. H. Frazier, Boston, Mass.
550 members.
New England Water Works Association.
Secy., Willard Kent, Narragansett Pier, R. I.
752 members.
New Jersey Association of County Engineers.
Secy., Edward E. Read, State House, Trenton, N. J.
29 members.
New Jersey Sanitary Association.
Secy., J. A. Exton, 75 Beech St., Arlington, N. J.
286 members.
New York Electrical Society.
Secy., George H. Guy, 29 West 39th St., New York City.
816 members.
New York Railroad Club.
Secy., H. D. Vought, 95 Liberty St., New York City.
1,600 members.
New York State Electrical Contractors' Association.
Secy., Geo. W. Russell, 25 West 42d St., New York City.
111 members.
Northern Railway Club.
Secy., C. L. Kennedy, 401 West Superior St., Duluth, Minn.
500 members.
Northwestern Cement Products Association.
Secy., J. C. Van Doorn, 834 Security Bank Bldg., Minneapolis, Minn.
250 members.
Nova Scotia Society of Engineers.
Secy., J. Lorn Allan, Halifax & Eastern Ry., Dartmouth, N. S.
127 members.
Ohio Association of Contractors.
Secy., A. J. Thatcher, 409 New First National Bank Bldg., Columbus, Ohio.
46 members.
Ohio Engineering Society.
Secy., C. J. Knisely, New Philadelphia, Ohio.
240 members.
Ohio Electric Light Association.
Secy., D. L. Gaskill, Greenville, Ohio.
204 members.
Ohio Society of Mechanical, Electrical and Steam Engineers.
Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.
265 members.
Oklahoma Civil Engineers' Association.
Secy., W. E. Moore, Oklahoma City, Okla.
40 members.
Oregon Society of Engineers.
Secy., G. L. Bliven, 513 Lewis Bldg., Portland, Ore.
210 members.
Pacific Coast Gas Association.
Secy., John A. Britton, 445 Sutter St., San Francisco, Cal.
357 members.
Pacific Northwest Society of Engineers.
Secy., Jos. Jacobs, 803 Central Bldg., Seattle, Wash.
200 members.
Society of Engineers of Eastern New York.
Secy., Louis L. Parks, 127 Glenwood Blvd., Schenectady, N. Y.
480 members.
Society of Engineers of North Central Washington.
Secy., W. C. Muldrow, Okanogan City, Wash.
16 members.
South Dakota Engineering Society.
Secy., R. G. Culbertson, Missouri Valley Engineering Co., Mitchell, So. Dak.
29 members.
South Dakota Engineers' and Surveyors' Society.
Secy., R. B. Easton, Aberdeen, S. Dak.
25 members (approximately).
Southern and Southwestern Ry. Club.
Secy., A. J. Merrill, 218 Grant Bldg., Atlanta, Ga.
400 members.
Southern Supply and Machinery Dealers' Association.
Secy., Alvin M. Smith, Smith-Courtney Co., Richmond, Va.
92 (companies) members.
Southwestern Electrical and Gas Association.
Secy., Dan. G. Fisher, 3419 Hall St., Dallas, Tex.
515 members.
Technical Society of the Pacific Coast.
Secy., Otto von Geldern, 1978 Broadway, San Francisco, Cal.
110 members.
Utah Society of Engineers.
Secy., W. C. Ebaugh, University of Utah, Salt Lake City, Utah.
Vermont Electrical Association.
Secy., A. B. Marsden, Manchester, Vt.
57 members.
Western Railway Club.
Secy., J. W. Taylor, 380 Old Colony Bldg., Chicago, Ill.
1,502 members.
Western Society of Engineers.
Secy., J. H. Warder, 1735 Monadnock Bldg., Chicago, Ill.
1,100 members (approximately).

Local Societies.

Albany Society of Civil Engineers.
Secy., Rupert Sturtevant, 278 Manning Blvd., So., Albany, N. Y.
103 members.
Boston Society of Civil Engineers.
Secy., S. E. Tinkham, 715 Tremont Temple, Boston, Mass.
794 members.
Brooklyn Engineers' Club.
Secy., Jos. Strachan, 117 Remsen St., Brooklyn, N. Y.
350 members.
Capt. John Ericsson Memorial Society of Swedish Engineers.
Secy., Algot Sylven, 29 West 39th St., New York City.
Car Foremen's Association of Chicago.
Secy., Aaron Kline, 841 No. 50th Ct., Chicago, Ill.
725 members.
Chicago Architectural Sketch Club.
Secy., C. H. B. Schaefer, 2919 Flournoy St., Chicago, Ill.
100 members.
Civil Engineers' Society of St. Paul.
Secy., D. F. Jurgensen, 116 Winter St., St. Paul, Minn.
88 members.
Cleveland Engineering Society.
Secy., F. W. Ballard, 413 Chamber of Commerce Bldg., Cleveland, Ohio.
500 members.
Cornell Society of Civil Engineers.
Secy., L. J. Sieling, 165 Broadway, New York City.
458 members.
Detroit Engineering Society.
Secy., Frederick H. Mason, 614 Moffat Bldg., Detroit, Mich.
277 members.
Engineers' and Architects' Club of Louisville.
Secy., Pierce Butler, Norton Bldg., Louisville, Ky.
144 members.
Engineers' Club of Baltimore.
Secy., J. H. Milburn, 13th Floor B. & O. Bldg., Baltimore, Md.
160 members.
Engineers' Club of Cincinnati.
Secy., E. A. Gast, P. O. Box 333, Cincinnati, Ohio.
175 members.
Engineers' Club of Kansas City.
Secy., Alfred Hurlburt, 910 Grand Ave., Kansas City, Mo.
124 members.
Engineers' Club of New York.
Secy., Joseph Struthers, 32 West 40th St., New York City.
2,000 members.
Engineers' Club of Philadelphia.
Secy., W. P. Taylor, 1317 Spruce St., Philadelphia, Pa.
603 members.
Engineers' Club of St. Louis.
Secy., W. W. Horner, 5203 Maple Ave., St. Louis, Mo.
322 members.
Engineers' Club of Toronto.
Secy., R. B. Wolsey, 96 King St. West, Toronto, Ont.
397 members.
Engineers' Society of Milwaukee.
Secy., R. H. Pinkley, 623 Frederick Ave., Milwaukee, Wis.
145 members.
Machinery Club.
Secy., Fred Stadelman, 50 Church St., New York City.
1,200 members.
Municipal Engineers of the City of New York.
Secy., C. D. Pollock, 29 West 39th St., New York City.
505 members.
Pittsburg Foundrymen's Association.
Secy., F. H. Zimmers, West Carson St., So. Side, Pittsburg, Pa.
142 members.
Providence Association of Mechanical Engineers.
Secy., T. M. Phetteplace, Brown University, Providence, R. I.
166 members.
Railroad Club of Kansas City.
Secy., Claude Manlove, 1008 Walnut St., Kansas City, Mo.
763 members.
Railway Club of Pittsburg.
Secy., C. W. Alleman, Pittsburg, Pa.
950 members.
Richmond Railroad Club.
Secy., F. O. Robinson, C. & O. R. R., Richmond, Va.
365 members.
Rochester Engineering Society.
Secy., Edw. F. Davison, 284 State St., Rochester, N. Y.
230 members.
St. Louis Railway Club.
Secy., B. W. Frauenthal, St. Louis, Mo.
1,150 members.
Swedish Engineers' Society of Chicago.
Secy., G. A. Akerlind, 3618 Lexington St., Chicago, Ill.
179 members.
Washington Society of Engineers.
Secy., John C. Hoyt, 1330 F St., N. W., Washington, D. C.
330 members.

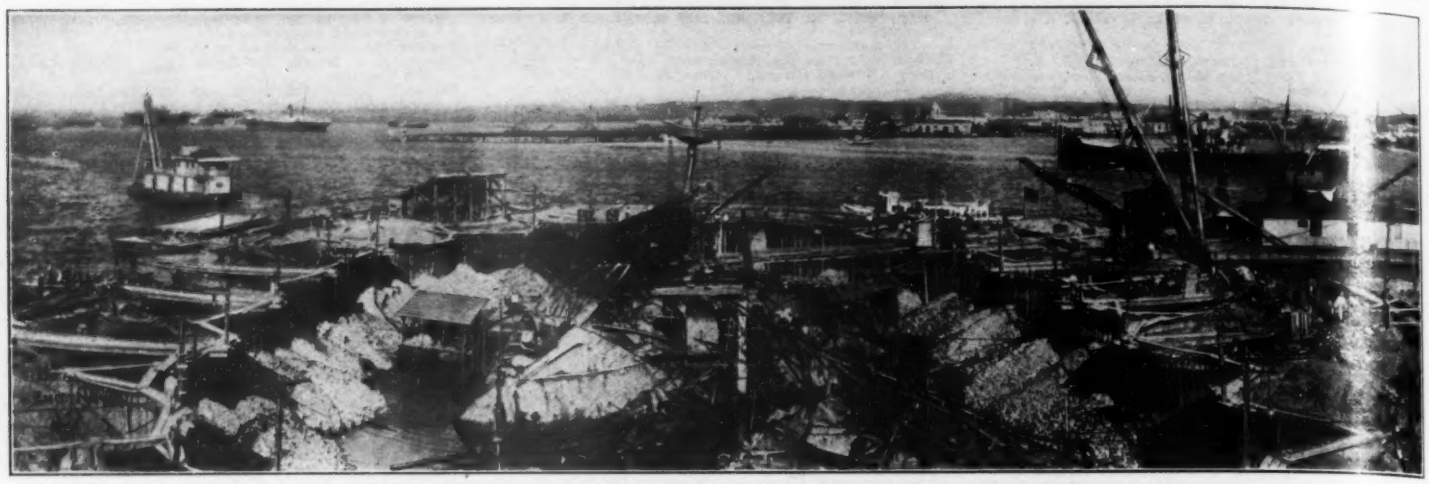


FIG. 1. THE "MAINE" COFFERDAM PUMPED DOWN 19.5 FT. ON JULY 21.
(Photograph by Underwood & Underwood.)

Progress on the Raising of the "Maine."

The latest press reports from Havana state that the cofferdam surrounding the wreck of the "Maine" has been pumped dry at a depth of 22 ft. below the harbor level outside. It will be remembered that the original soundings at the site showed bottom at 37 ft. and below that level at least 10 ft. of soft clay into which it was thought the hulk had settled, so that this finding of bottom some 15 ft. higher than it was before the cofferdam was built has been quite unexpected. The accompanying half-tones, from photographs taken during the week of July 16-22, partially explain the divergence between the two levels, and further show the shattered state of the wreck and the complication of the problem of removing it from the mud in which it is embedded.

Figs. 1-2 were taken on July 21, and show the water down to the 19½-ft. level. In Fig. 3, taken some few days earlier, the inside water level is about 15 ft. below the outside. Figs. 1 and 3 are both views looking across the dam from the shattered bow to the stern, which, as shown in Fig. 2, is in fairly good structural condition, although the corrosion of the steel plates has progressed very far. The bronze nameplate on the stern (Fig. 2) is apparently as smooth and clean as when it became submerged, over 13½ years ago.

These are the first views we have published that reveal the extent of the interior riprapping that has been dumped inside the cofferdam to exert counter-pressure against the cylinders and help them to sustain the pressure exerted by the water outside. It will also be noted that in every cylinder a large amount of the clay filling has been scooped from the inside half of the circle, on a slope which intersects the inner circumference at about the same line where the stone riprap commences, so that there is practically an even slope or fill from the middle of the cofferdam wall down to the bottom of the riprap dump inside the cofferdam.

If the photograph may be trusted, one or more of the cylinders have been tipped toward the wreck by the external water pressure, indicating the wisdom of their reinforcement by the riprap dump inside suggested in this journal in our original discussion of the plan. But while the riprap mounds appear sufficient for the present head of water against the dam, it looks as if they would seriously interfere with and perhaps prevent any complete exposure of the wreck.

FIG. 2. THE STERN OF THE "MAINE."
(Photograph by Underwood & Underwood.)

The "Maine" sank in 37 ft. of water, and during the years since the explosion she has certainly settled two or three feet into the mud, so that her bottom at its lowest point must be about 40 ft. below the harbor level. This is confirmed by Fig. 2, which shows the vessel's water line about 2 ft. above the water inside the cofferdam, which is 19½ ft. below the outside level. As the "Maine" drew 21½ ft. of water, this would indicate that her keel is about 39 ft. below the outside level of the harbor and some 19½ ft. below the water level shown in Fig. 2 inside the dam.

The day after this view was taken it is reported that the cofferdam was pumped dry at a depth of 22 ft., so there must be about 17 ft. of mud inside the dam which must be removed before the whole wreck can be exposed or any total removal of the hulk can be effected.

A large part of this 17 ft. of mud filling is probably the overflow from the hydraulic fill of the cylinders, pushed farther towards the middle of the dam by the heavy stone filling just inside the walls of the dam. Any attempt to remove this mud from the dam, either by dipper or by hydraulic dredges, so as to lay clear the wreck, will undermine the riprap and allow it to slide down onto the wreck and away from the cylinders which it is bracing. In that event more stone will have to be dumped in and possibly additional interior sheeting provided to hold the mud and stone away from the wreck. In any case the difficulties of the work are by no means over, nor the final expense as yet determined. An additional $250,000 is to be asked of Congress, which will bring the total sum appropriated to $900,000.

A number of bones have been taken from the portions of the wreck so far exposed, but no identification has been at all possible.

The Pressure of Loose Cement against bin walls is a very indeterminate quantity according to the paper on "Cement Stock Houses," recently presented to the Western Society of Engineers by Mr. Josiah Gibson. Mr. Gibson's observations are based on data acquired in the construction of a number of cement stock houses for the Universal Portland Cement Co. Portland cement when it comes from the mill is a loose, dry powder weighing about 95 lbs. per cu. ft. When dropped into the bins it becomes very freely charged with air and stands up with a level surface, like a liquid. After standing a few days its weight causes it to settle into a more compact mass from which practically all of the air has been expelled. Unfortunately its properties of internal friction are not constant and it is impossible to predict the degree of its angle of slope. When the cement is drawn from the bottom of the bin, sections of the storage space may be emptied leaving the remainder standing with almost perpendicular sides which, without warning, will cave in against the bin walls.

In one of the earlier bins to be built a series of experiments were made whereby it was decided that it would be safe to assume the cement to be a liquid of 10 lbs. per cu. ft. weight. It was soon found, however, that there was an excess deflection of the walls so designed and the assumption was increased to 20 lbs. per cu. ft. Later experiments were made by interposing some plank backed I-beams across an opening in the bin and computing the pressure from the deflection of those beams. This experiment showed that a hydraulic pressure of 20 lbs. per cu. ft. would be safe.

In the discussion of the paper this value was objected to as being too small, first, because the experiments did not care for the arching action of the cement and second, because the shock of the falling cement, noted above, was not considered. It was generally thought that a somewhat higher assumption should be made.

Railway Tests of Air-Brakes: 1878-1909.*

The air-brake was the invention of an American, and its success was early demonstrated at home, but the first important brake tests on scientific lines were made in England. These tests originated with a suggestion made by Mr. George Westinghouse before the Institute of Mechanical Engineers, London, 1878. He called attention to wide variations in shoe friction observed at different speeds, emphasized the importance of ascertaining the facts, and volunteered to design the recording apparatus necessary. The Institute assigned Capt. Douglas Galton, assisted by Mr. Horace Darwin, to the personal direction of these tests, which were made on the London, Brighton & South Coast Ry. and the Northeastern Ry. in 1878-9.

It may be said that the art of braking rests upon the facts and laws evolved from the Westinghouse-Galton tests. These trials established the following new principles: (1) permissible brakeshoe friction is limited by the adhesion between rail and wheel; (2) train retardation as measured by the coefficient of friction at the brakeshoe is subject to fixed laws directly affected and controlled by three factors: time, pressure and speed.

In 1886, the Master Car Builders' Association committee on Freight Train Brakes (Mr. Godfrey W. Rhodes, Chairman) arranged for a series of brake tests at Burlington, Iowa, on the C., B. & Q. R. R. These trials originated on account of the gradual increase in length of freight trains, the growing importance of interchange facilities, and the very evident necessity for the establishment of some standards in railway brake requirements.

FIG. 3. VIEW OF THE WHOLE COFFERDAM PUMPED DOWN 14.5 FT.
(Photograph by Underwood & Underwood.)

At that time, trains of 50 cars represented maximum operating conditions and this length of train was therefore specified as the basis of comparison. Two types and five different makes of apparatus were entered, including the Westinghouse plain automatic brake. The schedule of tests specified service and emergency stops from various speeds on level track and grades with different combinations of loaded and empty cars in the train, however, due to excessive train slack, amounting to 6½ ins. per car, and slow serial action of the brakes in trains 1,900 ft. long, very heavy shocks, destructive both to cars and lading, resulted during stops. The results of this series of tests were disappointing and unsatisfactory in the extreme, but exceedingly instructive. Recognizing the absolute necessity of developing a brake system providing practically simultaneous action throughout a 50-car train, or eliminating the slack between cars, or both, the committee postponed further tests until the following year.

Following these tests, brake manufacturers bent their energies chiefly toward improving quick serial brake action. In the Burlington tests of 1887 five different brake equipments (four compressed air and one vacuum) were again represented. All, with one exception, were operated either electrically or used electric auxiliary attachments for insuring simultaneous brake application throughout the train. The Westinghouse apparatus also included at this time a quick-action feature which was an attempt to accomplish quick serial action pneumatically. The results obtained, so far as pneumatic operation was concerned, however, practically duplicated those of the year before, showing pneumatic operation as then designed to be impracticable for 50-car trains by reason of shocks occasioned, but that an extraordinary improvement resulted in this particular when electric operation was employed.

Naturally the committee was favorably inclined toward electric operation and in recording conclusions stated: (1) the best type of brakes for long freight trains is one operated by air but actuated electrically; (2) this type of brake possesses four distinct advantages, (a) shortest stop distances, (b) elimination of shocks, (c) instantaneous release, (d) perfect graduation. Nevertheless the committee withheld any definite recommendations as to the type of brake that might be adopted generally and continued the subject for further investigation.

Following the Burlington tests of 1887 and during the autumn of the same year, Mr. Westinghouse produced his quick-action automatic brake by means of which the time of brake application through a 50-car train was reduced to three seconds. The Westinghouse train used in the Burlington trials was therefore equipped with the improved apparatus and sent on a tour of the country, runs being made at various railway centers. These private tests were remarkably successful, demonstrating the practical possibilities of all-pneumatic operation, thereby eliminating any necessity for electric operation with attendant complication, maintenance, etc.

So completely was the problem solved that the Master Car Builders' committee on Freight Train Brakes reported to the Association at Alexandria Bay, N. Y., in 1888, that "there is now a brake (non-electric) on the market which can be relied on as efficient in any condition of freight service." The principles of pneumatic brake operation thus evolved for freight service became at once generally accepted standards and so continued until within the last few years, when the quick-service uniform-recharge uniform-release freight brake was developed to meet modern conditions created in the operation of trains of over 50 cars.

In 1902, the value of the high-speed brake as compared with standard quick-action automatic brakes for passenger service was demonstrated in trials conducted at Absecon, N. J., under the supervision of the Pennsylvania R. R. A locomotive and seven cars (as well as shorter train combinations) were used and the conclusions derived were of unusual importance, showing over 20% shorter stops in favor of the high-speed brake at all speeds from 45 to 80 m. p. h. The need for the engine truck brake was also brought out by break-away tests, showing the normal stopping power of engine and tender brakes to be materially less than the train brakes.

In 1903, high-speed brake tests to determine maximum brake efficiency with available apparatus were made under the direction of the Central R. R. of New Jersey, at Atsion, N. Y. In general the conditions and results were similar to those obtained in the Absecon tests, the demonstrated loss in brakeshoe frictional efficiency with higher speeds emphasizing the vital necessity of compensating therefor through improved brake equipment.

In 1908, the Southern Pacific Ry. undertook the most complete series of brake tests since the Burlington trials of 1886-7. Perhaps the most important demonstration of this series was the possible increase in train tonnage on grades due to improved brake control. It was ascertained that the volume of traffic at certain points was limited not by the tonnage that could be hauled up the hill with powerful locomotives, but by the tonnage per brake that could be safely controlled down the grade. The use of Westinghouse quick-service uniform-release uniform-recharge freight brakes raised the normal tonnage rating for the Siskiyou to Ashland grade from 80,000 lbs. to 145,000 lbs. per operative brake; for the Siskiyou to Hornbrook grade from 80,000 to 132,000 lbs. per operative brake; and on Beaumont Hill from 110,000 to as high as 182,000 lbs. per operative brake, trains being controlled well within safe limits in every case.

These results were possible on account of quick serial service operation and the ability to keep the brake system charged to practically full pressure at all times. Few performances in freight brake history have been more spectacular than the increased tonnage rating possibilities demonstrated for heavy traffic work on long grades.

In 1909, at the instance of the Master Car Builders' committee on Air Brakes and Train Signals, the most important and complete passenger train control tests ever made were carried out on the line of the Lake Shore & Michigan Southern Ry., some distance east of Toledo, Ohio. The purpose of these tests was to determine the possibilities in stopping modern high-speed passenger trains. The results of these tests were exceedingly instructive, bringing out clearly large losses in braking efficiency during stops from high speeds with trains of very heavy cars weighing 125,000 lbs. and upwards which exceed the capacity of a single brake cylinder.* The practical effect of these trials was to indicate the necessity for a two-cylinder brake equipment in order to divide the work of braking, since a new brake of this type was required in order to stop these very heavy trains from a speed of 60 m. p. h. within 1,200 ft., the distance fixed upon by the M. C. B. committee.

In general, perhaps the most far reaching result of these trials was a realization on the part of the air-brake manufacturers and the railways of the vital bearing which present day conditions as to car weights, train lengths, train speeds, and train frequencies have upon the large problem of adequate braking.

*Condensed from information published by the Westinghouse Air Brake Co., Pittsburg, Pa.

*Engineering News, Jan. 12 and July 6, 1911.

Corrosion of Superheated Steam Piping by Soda was reported to the Dusseldorf convention of the Deutsche Giessereifachleute recently by Mr. F. Westhoff. He states that in a boiler plant working partly with saturated and partly with superheated steam (at 160 lbs. gage), the wrought-iron pipes and cast-iron valves of the superheated-steam line were badly attacked after four years' service, whereas the saturated-steam line was in excellent condition. Appearances suggested local solvent action. On close examination a whitish matter was found at the corroded places, which, on chemical analysis, proved to be in part at least sodium carbonate. Soda was used for softening the feed, and it seemed that the amount used was rather excessive; 1½ days after blowing down the boilers the boiler water showed 21.2 g. soda per 100 l., or 12.4 grains per gallon. The investigator concluded that soda particles were carried along with the steam, and that in the superheated-steam line they could deposit, while with saturated steam the condensation flow prevented deposits. He concludes that this deposited soda corroded the iron. ("Stahl und Eisen," June 29, 1911.)

Notes from the Bureau of Buildings, New York City (Manhattan), 1910.

The administration of building work in New York City as to public inspection and control is subdivided into five different parts corresponding to the five boroughs. The old City of New York is the present Borough of Manhattan, and by far the largest and most costly of building work goes on in this borough. We have an advance copy of the report of the operations of the Bureau of Buildings, Borough of Manhattan, for 1910, rendered by Mr. R. P. Miller, M. Am. Soc. C. E., Superintendent of the Bureau, to Mr. Geo. McAneny, Borough President. This report is unusual in giving more than the bare statistical figures; it contains analytical summaries of the statistics and notes on what may be called by-products of the year's work, so as to put on record the matters that were thought to have importance either to the Bureau itself or to builders and architects. We give below an abstract of some items of interest found in the report.

Of the Bureau's annual reports for some 15 or 20 years back only two—those of 1904 and 1905—contained anything more than statistical statements. It is now found that there is a continuous demand for copies of the reports of these two years, while requests for reports of other years are extremely rare. This fact throws light on the value of preparing full reports on the operations of important governmental offices.

BUILDING OPERATIONS.—In 1910 plans were examined and approved for buildings costing over $100,000,000. These embraced some 800 new buildings and 3,400 alterations, the new buildings representing nine-tenths of the total value. Table I gives the figures.

TABLE I.—BUILDING APPLICATIONS IN THE BOROUGH OF MANHATTAN, NEW YORK CITY, 1910.

	No. of applications.	No. of buildings.	Estimated cost.
New buildings...	778	838	$96,703,029
Alterations	2,989	3,367	11,940,066
Total	3,767	4,205	$108,643,095
Minor alterations.....			473,443
Total			$109,116,538

It will be seen that the average value per building was $115,000, and the average cost per alteration $3,550. Both as to totals and as to value per building the figures represent a marked decrease from 1909—11% in number of applications for new buildings and 26% in their cost.

The Bureau recently prepared a table giving the cost of buildings for which plans were approved during 42 years past. The record prior to 1902 includes Manhattan and varying parts of the present Borough of the Bronx, while since 1902 it includes only Manhattan. The influence of including the Bronx up to 1902 is not so marked, however, that the figures do not give a valuable comparison of the cost of building operations. We have summarized the table by decades and give the result as Table II.

It is noted that in 1910 the building operations of Manhattan represented an estimated cost slightly exceeding that of the other four boroughs combined, although the number of new buildings in each single one of the other boroughs considerably exceeded that in Manhattan. Only 6.3% of the total number of new buildings erected in New York City in 1910 were in Manhattan, but this small number represented somewhat over half of the total cost.

KINDS OF BUILDINGS.—Of the new buildings applied for during 1910 in Manhattan 26% were tenement houses. The complete classification of buildings for the borough is given in Table III.

It will be seen that about one-third of the total cost was put into tenement houses and one-third into stores and lofts, while one-eighth was used for office buildings. The item Stores, Lofts, etc., it must be understood, includes a large number of tall buildings; the increase of tall buildings for loft and factory use has indeed been the most marked development of New York City's building progress for at least five years past, being more characteristic even than the growth in those tall buildings that are devoted strictly to office use.

CHARACTER OF CONSTRUCTION.—It is of much interest to note what proportion of the total new construction is fireproof. An instructive table is presented in the report on this matter (Table IV).

TABLE III.—CLASSIFICATION OF BUILDING APPLICATIONS IN MANHATTAN, 1910.

Classification.	Number of buildings.	Estimated cost.	Cost per building.
Dwelling houses.....	43	$1,956,300	$45,500
Tenement houses.....	208	36,923,000	177,500
Hotels	7	955,000	136,400
Stores, lofts, etc.....	230	30,534,700	132,800
Office buildings.....	44	12,390,600	281,600
Manufactories and workshops	33	2,206,900	66,900
Schoolhouses	11	2,407,000	218,800
Churches	11	1,640,000	149,100
Public buildings—Municipal	8	3,158,000	394,800
Public buildings—places of amusement, etc.	40	2,652,100	66,300
Stables	60	1,469,720	24,500
Other structures.....	143	409,700	2,900
Totals	838	$96,703,029	$115,400

Note: Table covers new buildings only, i. e., alterations omitted.

FIG. 1. COLLAPSE OF OLD PARTY-WALL INSIDE OF NEW BUILDING UPON DEMOLITION OF OLD BUILDING ADJOINING.
(12 E. 32nd St., New York City; June 3, 1910.)

The very large preponderance of fireproof construction in floor area and in value is strikingly apparent from this table.

Examining the character of construction by districts (for convenience the Local Board districts were taken for this grouping), it appears that almost one-half of the total fireproof construction in the Borough of Manhattan for 1910 belongs to District No. 18 (Murray Hill District), extending from 3rd St. to 96th St., and from Lexington Ave. to Eighth Ave. The next two in order of magnitude of fireproof new buildings are District No. 19, extending from 66th to 133rd Sts., west of Eighth and St. Nicholas Aves., and District No. 14, which includes the westerly half of the Island south of 3rd St., and therefore embraces a large part of the office-building district. Even the Riverside District, however, does not amount to quite half the value of the Murray Hill District. The average values per building for these three districts ranged from $250,000 to $350,000.

On another classification plan of districting it was found that by far the largest amount of construction was for the strip between 23rd and 59th Sts., the figures for which amounted to about one-fourth those for the entire borough. This district represents substantially the same proportion of the total *fireproof* new construction.

VIOLATIONS OF LAW.—A total number of 6,137 violations of the building law were reported during the year (not including violations of the elevator regulations). About an equal number

TABLE II.—BUILDING APPLICATIONS IN BOROUGH OF MANHATTAN, NEW YORK CITY, FROM 1868 TO 1910 BY DECADES.

[Entire old City of New York represented to 1898, including present Manhattan and varying portions of present Bronx; Manhattan and larger part of present Bronx for 1898-1901; Manhattan only for 1902-1910.]

Year.	New buildings. Number.	New buildings. Cost.	Alterations. Cost.	Total cost.
1868-70	6,713	$109,538,738	$9,212,453	$118,751,191
(per year).....	(2,238)	(36,512,913)	(3,070,818)	(39,583,730)
1871-80	17,415	$226,472,414	$34,003,810	$360,476,224
(per year).....	(1,741)	(22,647,241)	(3,400,381)	(26,047,622)
1881-90	33,409	$537,038,477	$58,531,222	$595,569,699
(per year).....	(3,341)	(53,703,848)	(5,853,122)	(59,556,970)
1891-00	31,833	$727,991,086	$67,530,688	$795,521,774
(per year).....	(3,183)	(72,799,108	(6,753,069)	(79,552,177)
1901-10	13,496	$973,522,850	$125,298,820	$1,098,821,670
(per year).....	(1,350)	(97,352,285)	(12,529,882)	(109,882,167)
43 years		$2,574,563,565	$294,576,993	$2,869,140,558
(per year)		($59,873,571)	($6,850,628)	($66,724,199)

TABLE IV.—BUILDING APPLICATIONS APPROVED IN MANHATTAN, 1910, CLASSIFIED AS TO CHARACTER OF CONSTRUCTION.

Class of construction.	Number of buildings.	Ground area, sq. ft.	Floor area, sq. ft.	Estimated cost.
Fireproof ...	250	1,973,000	19,128,300	$72,874,000
	(31.0%)	(48.3%)	(68.0%)	(77.1%)
Ordinary	413	1,907,300	8,766,200	21,335,800
	(51.3%)	(46.7%)	(31.2%)	(22.6%)
Miscellaneous.	136	172,800	201,000	254,700
	(16.9%)	(4.2%)	(0.7%)	(0.3%)
Frame	6	30,300	33,200	11,200
	(0.8%)	(0.7%)	(0.1%)	(0.0%)
Totals	805	4,083,400	28,128,700	$94,475,700
	(100.0%)	(100.0%)	(100.0%)	(100.0%)

was disposed of during the year, leaving 3,345 violation cases pending at the end of the year, about the same number as taken over at the beginning. Over 27% of these were for plumbing and drainage (installing without permit or constructing contrary to plans or regulations).

A remarkable passage in the report is as follows:

> Starting new buildings or alterations without a permit is also an altogether too frequent occurrence. Nearly 22% of the violations reported were for this infraction of the law. In the more serious cases of such violations, injunction proceedings are resorted to, but even in some of these the work has often been completed before the injunction could be obtained. Thus, for instance, a frame structure within the fire limits, requiring only a short time for erection, was practically completed, under cover of a board fence, before the injunction could be obtained.
> * * *
> A class of violations that has been particularly troublesome is the erection of frame structures within the so-called fire limits, that is, the portion of the city in which such structures are prohibited. One hundred and sixteen such cases were reported in 1910 and quite a number were still pending from previous years.

A curious light is thrown on the efficacy of legal remedies by a statement in the report that some of the pending violation cases are 16 years old and very many are from five to ten years old. Most of these have long ago been turned over to the Corporation Counsel for attention, but are still pending. There are now over 1,500 violation cases from one to nine years old in that law office still unsettled. The report further remarks:

> In the prosecution of cases by the Corporation Counsel 80 judgments were secured during 1910, amounting to $14,810.98, of which four amounting to $245.23 have been paid, leaving a balance of 76, amounting to $14,565.75, unpaid. The futility of attempting to enforce the building law by the levying of a penalty is shown in this summary. In the majority of cases the judgment is not collected and a separate suit must be brought to secure a compliance.

SAFE SIDEWALK SHEDS.—Early in the year the bureau established regulations requiring the construction of more substantial sidewalk sheds than had been common, wherever building work is in progress. The requirements were printed in Engineering News, April 7, 1910, p. 397. This work is referred to as follows:

> When the present administration took charge of this bureau, it was found that a really satisfactory shed was provided in very few instances. In most building operations if a shed was at all provided it was of such a flimsy nature as to be of no value or protection to pedestrians. Sometimes the shed itself was so poorly constructed as to constitute a menace to the public. In two serious accidents that occurred in Manhattan during 1910, fatal results would probably have been avoided if substantial bridges had been provided, as required.

Many cases of inadequate sidewalk sheds are included in the above number of violations, accounting for a considerable increase over the previous year.

BUILDING ACCIDENTS.—Under the heading of unsafe buildings the report briefly summarizes the cases of unsafe buildings that arose during the year and the action taken. A total number of 2,341 "unsafes" were filed during the year. In 1,993 cases the structures were made safe by the owners upon order of the bureau, but in 104 cases it was necessary to make application to the Supreme Court to compel repair. In about 5% of the cases buildings were taken down, the others being made safe by less heroic methods.

The Bureau of Buildings is charged with undertaking all emergency work connected in any way with building operations that may arise. When possible competitive bids are asked for such work, but occasionally the action must be so prompt that this is not possible. It is interesting to recall that one of the emergency cases which was placed upon the Bureau of Buildings in January, 1910, was digging up the body of one Finkelstein, who had dug a tunnel under Ludlow St. with the idea of getting into a jewelry store on the opposite side and was killed by caving of the roof half way across the street.

Two noteworthy emergency cases are shown by the views, Figs. 1 and 2, herewith. In the first case (June, 1910) a large piece of a party wall of a tall building fell when the adjoining building was taken down. It exhibits the very poor character of some old party walls.

The case shown in Fig. 2 was the sudden sagging of one corner of a narrow building on West Broadway and Park Place, June 14, 1910. The picture shows the appearance of the building. The structure was pulled down on the following day. Investigation showed that the easterly part of the long north wall was supported by several cast-iron columns which had a peculiar box-shaped cap straddling the flat top of the column shaft. The lower connections of this box broke and allowed it to fall about a foot with its superincumbent load, when it again came to bearing as the top plate of the box seated itself on the top of the column shaft. The building was very old and nothing farther was learned about this unusual detail of construction.

FIG. 2. PARTIAL COLLAPSE OF OLD FIVE-STORY BUILDING FROM FRACTURE OF BOX-SHAPED CAP OF CAST-IRON COLUMN.
(S. W. cor. West Broadway & Park Place, New York City, June 14, 1910.)

FIRE-ESCAPES.—The report goes at some length into the matter of investigation of fire-escapes and the work done toward securing compliance with law, as follows:

> None of the duties resting on this bureau seem so onerous as that imposed by Sections 103 and 108 of the Building Code, to provide adequate egress from buildings in case of fire or panic. **None of the orders issued by this bureau are so strenuously resisted as those calling for proper and adequate means of egress.** The provisions of the law are not specific and perhaps cannot be, but the responsibility for adequate exit facilities is clearly placed on the Superintendent of Buildings. A force of six inspectors has been assigned to this work especially, and besides this, the district inspectors report on many cases.
> While it has not been possible to lay down any specific rules, certain general principles have been adopted for the guidance of the inspectors. An endeavor is made to secure as far as possible safe egress within the structure itself by enclosing all staircases in fireproof walls with self-closing fireproof doors on the openings. A means of escape is thus formed with which the occupants are thoroughly familiar and which when properly constructed does not subject them to the dangers of the outside fire-escapes, the majority of which do not lead to direct or easy egress.
> The proper means of egress is of necessity largely a matter of judgment, and much difficulty is experienced in convincing owners or lessees that additional exit facilities are required.
> Complaints as to the lack of fire-escapes or proper means of egress come from several sources, chief among them the State Factory Inspector and the Fire Department. Some cases come from the Tenement House Department and many from employees in business buildings or factories and tenants in residences. Some are anonymous and some are clearly inspired by animosity. An unusual number of them have reached this bureau since the fatal Newark factory fire on Nov. 26, 1910. All the complaints, no matter from what source or motive are investigated.
> During 1910, 872 cases have been reported in which fire-escapes or other improvements to exit facilities were considered necessary. The general character of the orders and the types of buildings to which they apply are indicated in the following table [Table V. The disposition of the cases is given in Table VI].

Of the cases still pending, an unusually large number was filed in December, due to the outcome of the Newark factory fire. Deducting the December excess, the number of left-over cases at the end of 1910 and 1909 is in fair agreement. Many of the pending cases are from two to seven years old, most of which are in the hands of the Corporation Counsel but have not yet been attended to.

UNLICENSED PLUMBERS.—At the instigation of the Mayor, a special campaign was made against plumbers not licensed and registered, as required by law. The total number reported was 137. This represents about six months' work. The work is hampered, however, by the fact that all collection of facts and evidence and ap-

TABLE VI.—DISPOSITION OF FIRE-ESCAPE CASES.

	1910.	1909.
Cases pending Jan. 1	385	454
Reported during year	872	496
Total	1,257	950
Orders complied with	821	565
Pending Dec. 31	436	385
In hands of Corporation Counsel for prosecution	241	287

TABLE V.—FIRE-ESCAPE CASES, MANHATTAN, 1910.

Nature of building.	Outside fire-escapes.	Fire-escapes out of repair.	Remove obstructions.	Provide F. P. stairways, etc.	Doors to open outward.	Total.
Work-shops	258	111	58	40	0	467
Lofts	54	34	10	1	0	99
Store and office	34	12	5	0	0	51
Store and dwelling	18	10	1	0	0	29
Store and tenements	1	3	1	0	0	5
Hotels	62	29	10	0	0	101
Places of assembly	21	11	1	2	14	49
Warehouses & storage	5	10	3	0	0	18
Garages and stables	14	4	0	0	0	18
Schools	16	2	0	0	1	19
Nurseries	2	0	0	0	1	3
Hospitals	4	0	0	0	0	4
Synagogues, mission houses, etc.	6	1	0	0	2	9
Totals	495	227	89	43	18	872

pearing at court was done by the regular force of inspectors in addition to their current duties.

ELEVATORS.—The Elevator Division had a total of 8,420 passenger elevators under inspection and during the year received 692 applications for new elevators or alterations. It is estimated that there are about 10,000 freight elevators in Manhattan additional to the figures given above. Periodic inspections are made on passenger elevators only. About 1,000 violations were reported during the year. Running gear, doors and locks, ropes and safety catches account for about two-thirds of these.

Fig. 3. Broken Elevator Sheave Strap Taken from Passenger Elevator of a Ten-Story Office-Building.

Elevator accidents are not fully reported. A record was attempted during the last five months of the year, showing ten passenger and four freight elevator accidents, with seven persons killed and fourteen injured. Six were due to defects in ropes or machinery and five to carelessness of the passengers.

DEFECTIVE ELEVATOR SHEAVE STRAPS.—An unusual case with an unusual result arose out of an accident to a passenger elevator in an office building early in the year. The car dropped and injured a number of passengers. Examination showed that the traveling sheave straps had broken and it was learned that a short time before exactly the same accident had happened in a large department store.

Investigation showed that many of the old type vertical hydraulic elevators in the city were equipped with the same form of traveling sheave straps. A careful consideration of the construction led to the conclusion that all these elevators were liable to the same accident. It was impossible to tell from an inspection, without dismantling the machinery, whether the sheave straps were in good condition or not, as they were covered by other parts.

After consultation with representatives of the elevator manufacturers and the casualty and other elevator insurance companies on May 2, 1910, a new regulation calling for the reconstruction or reinforcing of all such straps in use, was promulgated and published as widely as possible. Inspection of all the existing vertical hydraulic elevators was made and orders issued to comply with the new regulation. Some opposition developed but it was soon dispelled when it was pointed out that non-compliance meant the liability of serious accident at any time.

Of the 1,094 vertical hydraulic elevators in Manhattan, 1,027 have at this time had their sheave straps replaced or reinforced in accordance with the new regulation, leaving only 67, or a little over 6%, to be still attended to. [In July, 1911, only 8 remained unreconstructed, and most of these are out of use.

That the new regulation was fully justified is indicated by the fact that in 16 cases it was reported that the straps were found broken when the machinery was taken apart. It was mere good fortune that more accidents had not occurred. It should be added that it is probable that straps in more than 16 cases were broken, inasmuch as the work of replacing and reinforcing, to avoid as much as possible an interruption of the elevator traffic, was generally done on Sundays or holidays or at night when the inspectors were not present, so that they did not always see the straps that were removed.

While the straps were being reconstructed or reinforced, in a great many cases, the piston rods of the elevators, which also cannot be inspected without dismantling the machinery, were examined and quite a number were found to be defective and had to be removed.

One of the broken straps is shown by the view Fig. 3.

[The sketches in Fig. 4 herewith, not shown in the report, illustrate the condemned form of strap and several replacement forms. The old strap, shown at A, is a U-shaped strap made of two flat bars in close contact except at the head of the U, where they are usually separated by a babbit filling. The counterweight is held between the legs of the strap, and the piston-rods are attached to a cast-iron saddle set in the bend; the machine only pulls down on this traveling sheave frame, the return being accomplished by the elevator pulling the sheaves up. The variation of stress at the bend seems to produce a liability to fracture. Due to the babbit filling and the arrangement of saddle and rods, fractures of one bar are often not discovered, and the danger is not known until the second bar also breaks. The sketch B shows a form of construction used by elevator builders after they had discarded the form A, some years ago. In reconstructing the old straps upon the Building Bureau's order last year, various methods are used, two being shown by sketches C and D. Sometimes the U portion of the old strap was cut off and eyebar heads welded on, carrying the crosshead block on a pin, as in C. In other cases new eyebars were put on outside the U-bars, leaving the latter undisturbed but giving them direct support by a connection pin and block under the bend. The same plan sometimes used screw-end bars instead of eye-bars, as in sketch D.]

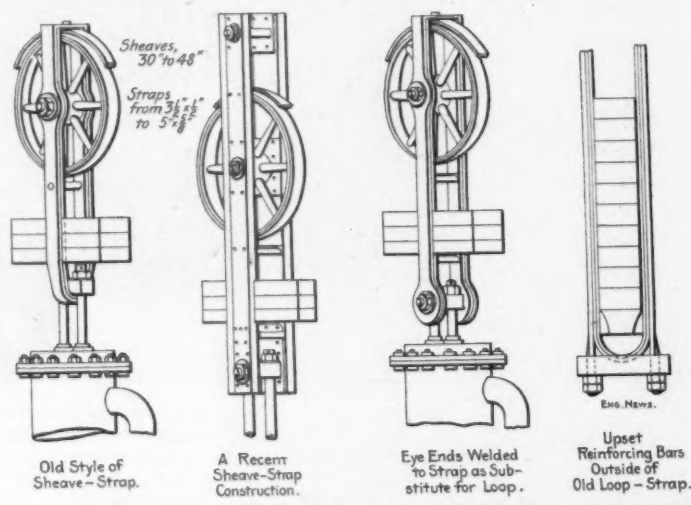

Sheaves, 30"to48"
Straps from 3½"x⅝" to 5"x⅝"
Old Style of Sheave-Strap.
A Recent Sheave-Strap Construction.
Eye Ends Welded to Strap as Substitute for Loop.
Upset Reinforcing Bars Outside of Old Loop-Strap.
ENG. NEWS.

FIG. 4. SKETCH OF OBJECTIONABLE SHEAVE-STRAP CONSTRUCTION, A NEWER TYPE, AND TWO SCHEMES USED IN REINFORCING OLD-STYLE STRAPS.

BRICK AND BLOCK TESTS.—Regulations covering the testing and approval of new materials having the form and general character of brick (intended for sand-lime brick, concrete blocks, etc.), were issued by the Bureau in 1905 as the result of tests reported in Engineering News, April 13, 1905. Many tests have been made since that time on materials falling under these regulations. The average results of all the tests of brick, etc., made to date under the auspices of the Bureau are given in Table VII.

TABLE VII.—AVERAGE RESULTS OF BRICK AND BLOCK TESTS MADE BY BUREAU OF BUILDINGS, MANHATTAN, UP TO 1911.

	Number of specimens.	Modulus of rupture. lbs. per sq. in.	Compressive strength, lbs. per sq. in. Dry.	Wet.	Frozen.	Absorption, by weight, %
Clay, common	59	469	3,959	2,702	....	15.00
Clay, pressed	6	983	6,361	5,934	....	9.80
Cement 1:4	5	475	4,394	2,594	2,700	10.97
Concrete, 1 Portland cement, 1-2 marble dust, 2-4 limestone	7	895	4,180	2,537	....	....
Cement not recorded	6	457	2,212	....	....	8.4
1 Portland cement, 2-5 trap rock	10	696	3,856	3,326	4,824	9.4
	12	506	4,746	3,678	....	5.7
Clinker	150	560	3,878	3,084	3,362	12.34
Sand lime						

A Large Riveted Steel Stack has been recently erected in Cleveland, Ohio, at the foot of East 70th St. for the new power-house of the Cleveland Electric Illuminating Co., where it will serve 18 boilers of 600 HP. each. The height of the stack alone is 216 ft., which is increased to 273 ft. by the structural supports. The outside diameter is 22 ft. at the top and 40 ft. at the base where it flares out like a bell. The diameter inside the brick lining is 18 ft. 6 ins., the same from top to bottom. While it is not the highest in the world, it is claimed by the builders, the James McNeil & Bro. Co., of Pittsburg, Pa., that this is probably the largest steel stack, considering both height and diameter. The weight of material in the stack proper, not including supports, is given as 400,000 lbs. A total of about 30,000 rivets were used in its construction.

Four different thicknesses of plates are used in the stack walls, decreasing by sixteenths from 7/16-in. thick at the base to ¼-in. thick at the top. Each thickness of plate is used over a length of from about 35 to 55 ft. of the stack. The brick lining extends from top to bottom, varying in thickness from 26½ ins. at the bottom to 4 ins. at the top. Its thickness is decreased by steps of several inches each at intervals of from about 30 to 55 ft. The breeching opens into the stack at two points directly opposite each other. The openings are 13 ft. square. The stack is held to its foundations by 14 anchor bolts each 10 ft. long by 2 ins. in diameter. At both ends of each bolt a length of 6 ins. is upset to 2½-in. diameter for threading. Four similar additional bolts, each 6½ ft. long, are used at the foot of the jamb posts of the breeching portals.

How Judge Gary's Scheme for Friendly Cooperations among steel manufacturers appears to a foreign observer.—A magnificent banquet was given last week by the Duke of Devonshire and a committee of the Iron and Steel Makers of Great Britain to a large number of notable guests from America, Belgium, France and Germany. The object of the banquet was apparently to usher in a new millennium in which the lions and lambs of the iron and steel trade are to lie down together, and the old Adam is no longer to inspire in the lion designs upon the lamb nor in the lamb fear as to the lion's intentions. Judge Gary, president of the United States Steel Corporation is the apostle of this new doctrine of peace. He spoke eloquently upon it after the dinner, but left us with very vague notions as to the precise objects he has in view. Broadly speaking, however, we gather that he aims at the establishment of an international understanding as to the prices of iron and steel. There is to be competition, of course, but it is, if we understand him aright, to be open competition in the sense that every competitor will state frankly what he proposes to do. It is to be presumed that prices will be settled at general committees, and that undercutting will be strictly prohibited. Presumably also spheres of influence will be prescribed, to overstep which will be hitting below the belt, and will be visited with penalties. The imagination of the altruist is fired by such schemes of universal bliss, whilst the matter-of-fact man who believes that fighting is inherent in human nature looks on them with some suspicion. Judge Gary was supported by Belgian, British, French and German representatives of the iron and steel trades, who were all equally careful not to commit themselves too far, and to say nothing that would dim the post-prandial harmony of the evening. It was left to Mr. Bonar Law, in a speech remarkable for its excellent good nature and sly wit, to suggest that human nature had still to be bargained with.—"The Engineer" (London), July 7.

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Rusting, Rust-Prevention and Paint.

Supplementing our report of the highly practical exposure tests of paints at Havre de Grace bridge and at Atlantic City, as printed in our last issue, we give in the present issue a group of articles bearing on the same general subject, namely, how iron can be protected against rusting. The one side of this subject deals with protection by paint; the other side with the problem of ennobling the metal itself so as to resist corroding influences. It is likely that both these problems will always be with us; we will always have to rely on paint, since the most sanguine hope does not look toward complete ennobling of iron but expects only to reduce its present rapidity of rusting. There is a better chance of obtaining imperishable paint than of making the naked iron everlasting.

The article on ship's-bottom paints by Naval Constructor Williams suggests that many special fields of use of paints will need to be investigated after the question of paint in ordinary atmospheric exposure has been settled. Experimental study of paints is bound to continue for a long time to come, if present paint materials are not replaced by something radically better.

Of the work being done on the problem of improving the durability of iron, there is some evidence in the three papers which we have grouped under the head, "Comparative Corrosion Tests of Steels and Irons." The primary problem of finding a suitable test method has not yet been solved, however; the three papers mentioned give clear illustration of the great variability of test results. Progress toward ennobling iron can hardly be expected until more positive test methods are devised. Perhaps it will prove necessary even to formulate a number of tests, each furnishing a different result for a given iron, and to express the quality of this iron by the whole set of figures ordinarily, combining them for any specified exposure by an appropriate scale of addition to express total effective durability.

In default of reliable tests, it must long remain true that the most valuable information is that obtained from long-continued weather exposure, a quarter to half a century or more. This in turn means that for present-day knowledge we must look to old irons exposed for many years past. Few cases of this kind come under observation, and in these it is rarely possible to learn what were the origin and treatment of the material and what were the conditions of its exposure. Yet one or another item of valuable information is likely to result from every such case, and the accumulation of these items will ultimately afford a basis for valid conclusions. The series of tests of iron from the chains of the century-old Newburyport bridge by Prof. A. P. Mills is therefore of decided value, and there is an unexpected interest in the finding of copper admixture as a probably controlling factor. The observations of Prof. W. H. Walker, in his paper, concerning the effect of copper in iron, are suggestive in connection with Prof. Mills' findings.

Amateur Experts in the Field of Railway Safety Appliances.

In commenting on the Bridgeport disaster recently, we noted the common tendency of the amateur who tries to cure one danger in railway operation to create worse dangers than those which he tries to obviate. An excellent illustration of this is the curious recommendation made by the Coroner's Jury which conducted the inquest on the Bridgeport victims, that high-speed trains should have two engineers in the cab.

There are places, unquestionably, where two heads or three heads, or even five heads, are better than one. There are problems, as we have often urged in this journal, on which the judgment of a commission of able experts is better and safer than the judgment of one man. But when the question is the identification of a railway signal light from the cab of a locomotive running at 60 or 70 miles an hour with a loaded passenger train behind it, then is most emphatically *not* the time to wait for decisions of a commission. A train running 60 miles an hour passes over a distance of 1,000 ft. every 12 seconds. There are stretches of crooked road where an engineer does not have more than half a dozen seconds to read a signal as he passes it. Somebody must decide; and to place the responsibility on two men would have the inevitable result that each would rely upon the other.

As a matter of fact, it is hardly to be expected that two men are going to watch signals from beginning to end of a run when one is perfectly competent to do it. It would be simply a matter of taking turns at the throttle. Such a measure might suit the labor unions, and would unquestionably add heavily to railway operating expenses; but it would be a measure contributing to danger rather than to safety.

Another example of amateur advice is given in an editorial in the "Outlook," which declares that the cross-over from the express track to the local track ought to have been a trailing switch instead of a facing switch, so that the engineer of the Federal Express would have been obliged to stop and back up in order to get on to the local track.

Engineers are perfectly well aware that facing-point switches should be avoided when it is possible to do so; but if the cross-over were trailing for the express, it would be facing for the local track, and local trains run just as fast between stations as express trains. Further than this, if the switch were trailing for the express track, the express train in order to get on to the local track would have to back up the line *against the direction of traffic*. Of course, it would have been protected by signals in this movement; but so was the cross-over protected by signals. We believe the risk would be far greater of introducing this movement in a reverse direction onto the local track than was involved in the track as actually in place.

The fact ought to be faced that unless obedience to signals can be enforced, no train is safe on any stretch of track. It is more essential to concentrate attention on the problem of how to secure obedience to signals than to discuss such minor questions as whether the cross-over might have been differently arranged or the traffic differently conducted.

Concerning the Exploiting of Young Engineering Graduates.

In the "Bulletin" of the Society for the Promotion of Engineering Education for June, an interesting letter is published relating to the compensation of graduates from engineering schools. The letter suggests questions of such direct interest to the profession that we print it nearly in full, as follows:

Sir—A matter which, it seems to me, ought to come before your Society is that of the compensation of engineers. Strictly speaking this should be looked into and, as far as possible, regulated by an association of the Deans of professional schools.

A professor in a well known high school has for a long time past conducted a sort of employment agency for the boys who leave that school either by graduation or in advance of it, and he has so improved the conditions of employment that it is greatly to the interest of the boys to have good records at the school.

For example, one of the large institutions in his town was in the habit of taking eight or ten boys every year to be trained for its work. Of course it wanted the best, but it did not want to pay them. The professor investigated the conditions under which they worked and found that they were not getting what they were worth, or in fact what amounted to a decent living. He thereupon reported to the president of the company that the boys could not stay there unless they had adequate promotions in accordance with their terms of service.

The first attitude of the corporation officers was one of very earnest resentment, and they informed the Dean in turn that it was none of his business. He then struck the name of the company off the high school list, and put up in the school a notice that it did not treat its boys fairly. Furthermore, he told four of the young men who were employed there to leave the service and provided places for them elsewhere, since the high school is swamped with applications all the time. The result was a visit from the president of the corporation and a decided difference in his tone, but they were kept off the list for a year and had to get boys without high school education. Of course he has the cooperation of the principals of all the high schools in his town, and it is his aim to keep boys out of the "blind alley" occupations.

Now I believe it is possible to deal with the professional situation in somewhat the same way. I do not hesitate to say that in all the large engineering commercial enterprises such as the Edison and the Interborough companies here and in others of similar character in other places the average professional pay is not what is earned by a good clerk. I know, for instance, engineers who after several years with the corporation are getting $25 a week. These are men of mature years, of good intelligence and with professional training, who certainly are entitled to a living salary.

Such a situation would be impossible if the work of the graduate were followed up by the dean and the corporations were given to understand that they could not have graduates of Columbia, Cornell, Tech., Stanford and so on, at any such prices. I realize that when your men graduate they are anxious to get placed at once, and further, that under former systems of education they were not much good for the first six months; but I don't believe that is the case any longer. My experience here in New York and to a certain extent in other places is that it is the younger men who come to the work with fresh points of view (admittedly sometimes too fresh) who make the improvements and do all the harder part of the work; in many cases the manager or chief engineer or even the technical vice-president gets the credit and reads a paper about it at an engineering society meeting.

Such a scheme could only succeed, of course, when carefully worked out and by the cooperation of all of the first-class schools. I believe it would have the endorsement, if properly presented, of the engineering societies, and might in time beget a wholesome esprit de corps amongst engineers and some sense of loyalty to the profession; I regret to say that both of these are now generally lacking. Yours very truly,

New York City, March 28, 1911. T. J. Johnston.

It is frequently declared by the heads of our leading engineering schools that the demand for their graduates is greater than the supply; and that there are more positions offered to the members of the graduating class each year than there are graduates.

It has always seemed to us difficult to reconcile this frequently-published statement with the fact that at the same time not a few engineers of education, experience and ability are looking for positions and unable to obtain employment. There is a good deal of evidence to indicate that in not a few cases concerns which employ engineers in various subordinate capacities pre-

fer to employ young graduates because they can get them at a very much lower salary than they are obliged to pay to men who have accumulated years of experience.

The young graduate has been told time and again that he must expect to work for little or nothing during the years while he is gaining experience. He is therefore ready to work at anything for starvation wages or even less, if he is fortunate to have means or friends on whom he can rely for a living. There is reason to believe that many concerns find it profitable to employ this class of engineering assistants rather than pay salaries which the work ought to be fairly worth.

It may be argued that to a certain extent it is a healthy thing for the profession to bring into it a large supply of bright young men, well trained in the fundamentals, and allow by a survival-of-the-fittest process those who are ablest to come to the top and lead the profession. We believe, however, that this process has injured the engineering profession far more than it has benefited it. A strenuous competition has been created which has lowered the compensation in many lines of engineering work until many able and competent men have been driven into other lines of business.

Investigations have been made which indicate that a large proportion of the boys who start in to take engineering courses in our colleges have the vaguest ideas and the most exaggerated anticipation as to the future possibilities of success in their profession. In the number of the "Bulletin" which is above referred to, there is described a course of instruction for first-year students established by the professors in the Department of Electrical Engineering at Stanford University.

In this article it is stated that investigation pursued in connection with this course showed that most of the young men entering college firmly believed that the possession of an engineering degree would of itself place the holder on the road to success and a large salary, and that at a date not very remote from graduation. They admitted that for the first few years their lot would be hard work with low pay, but were firmly convinced that once embarked upon the road industry would bring its full reward.

It is not a good thing to educate men for one particular narrow line of work for which they are to spend years of valuable time and thousands of dollars of money in preparation, and have a large proportion of them ultimately meet bitter disappointment because of the meager salaries they are able to command in mature years.

We have no faith in such remedies for the present situation as the placing of legal restrictions upon the practice of the profession, which has been so earnestly advocated; neither is there any hope of relief in the project to make over the engineering profession into a trade union. Remedies must be sought by remodeling our engineering schools so that the education they give will aid the average student to take up almost any line of industrial work in business, or commerce, or finance, or professional activity. We must educate fewer and better men for the actual work of the engineering profession.

Some way must also be found by which the engineering profession can place its best men in places of greatest responsibility, but that is another story.

Changes in the Organization of the National Engineering Societies.

In connection with the long list of engineering societies of the United States, which is published elsewhere in this issue, it seems worth while to summarize some of the radical changes which are now in progress in the great national engineering societies, because some of these changes can be traced, more or less directly, to the great multiplication of engineering organizations which has taken place in recent years. It will surprise most of our readers, without doubt, to see how many societies there are which have more or less to do with engineering work and engineers. Most of these societies have originated within the last twenty years, and many of them within the last ten years.

This is a very different condition from that existing when the oldest of the four chief national engineering societies, the American Society of Civil Engineers, was organized. That Society at its start in 1852 and for many years thereafter was the only organization of engineers in the United States, save for a few local societies which were little more than social clubs. In fact, the American Society of Civil Engineers itself was for many years actually a local club which aspired, because of its headquarters at the commercial and financial center of America, to become a truly national society of engineers.

To a certain extent, the traditions which pertained to the early history of this Society have been maintained to the present day. The Society has always held its regular meetings at its headquarters in New York City, and except for its annual summer convention, which has always been more of a social than professional gathering, it has never held meetings anywhere else. It has further recognized the fact that its members resident in New York City and vicinity obtained greater benefit from their membership than out-of-town members by charging the New York resident members a higher rate of dues than others.

The second of the great national societies to be organized, the American Institute of Mining Engineers, has always been a peripatetic organization. It has held three meetings annually for many years, and the aim has been to scatter these meetings in various cities in different parts of the country, so that all geographical sections, if not equally favored, should at least have some recognition.

The American Society of Mechanical Engineers until very recent years held only two meetings a year; one, the annual meeting held at New York City in December, and the other, the Spring meeting, held each year in a different city. The proposal to hold monthly meetings at the headquarters in New York City was for years defeated on the ground that the out-of-town members would feel that those resident in New York were receiving greater benefits from their membership.

It was left for the youngest of the four great societies, the American Institute of Electrical Engineers, to first recognize the anomaly of having an avowedly national society confine its meetings to a single city, and the almost equal anomaly of a great engineering society, dealing with matters where progress is recorded every week and every month, holding meetings of its members only twice or three times a year. The Institute of Electrical Engineers was the pioneer in organizing among its members local branches, in different cities throughout the country, which meet at intervals and obtain the same benefit of mutual acquaintance and opportunity for discussion of technical subjects as do the members resident in New York City who attend the meetings at the headquarters there.

Within the last two years the example of the Electrical Engineers has been followed by the Mechanical Engineers, and that society now has branches successfully organized in Boston, St. Louis, New Haven, Philadelphia and San Francisco, while work is in progress for the organization of other local branches.

The American Institute of Mining Engineers has also taken up with energy the organization of local branches, and has under way radical alterations in its constitution and general system of organization to enable such local branches to be successfully conducted.

In Canada, the Canadian Society of Civil Engineers has been working energetically for some time to foster the organization of local branches, and now has such branches at Winnipeg, Toronto, Ottawa, Quebec and Vancouver.

Even in the American Society of Civil Engineers, while the governing body of the Society has looked with no favor on any project for local branches of the Society, the members resident in San Francisco and in Washington, exercising their rights as free-born American citizens, have in each city formed an organization of their own, which holds regular meetings and is carried on very successfully and profitably.

It may be well to note in this connection also that the national society of the architectural profession, the American Institute of Architects, has always been organized with the local chapters of the Institute as its foundation. The only headquarters of the Institute is the headquarters at Washington, where the general secretary has his office, but Washington members have no advantage over the members resident in any other city. Each city has its local chapter, which holds regular meetings, and the annual convention of the Institute is held in different cities of the country, wherever the governing body of the society selects.

Beyond question, this is really the proper basis on which to organize a truly national society. This is recognized now in the American Society of Mechanical Engineers, where the monthly meetings held in New York are conducted by a local organization of New York members, just as are the meetings in St. Louis, although the general headquarters of the Society are located in New York City.

A great deal of discussion and of "concussion" between the progressive elements and the conservatives has gone on in the several national societies regarding the organization of these geographical branches. There have not been wanting those who have honestly feared that the standards of the society would be hopelessly lowered and that its unity would be destroyed if members resident in this and that and the other city were allowed to get together and hold meetings. That some guidance and control of the local organizations by the parent society is advisable will, of course, be recognized. A local organization could not safely be given unlimited authority to commit the parent society to commendation of new devices, or to unlimited financial obligations, for example.

The best solution so far for these problems, however, seems to be to make each local branch of a society autonomous and allow it to run its own affairs, financial and technical, with the friendly cooperation of the officers and standing committees of the national organization and assistance of its machinery.

On the financial side, it seems to be agreed that a part of the annual dues to the national societies from members resident in a given city ought to be available to pay the expenses of the local organization in that city. This is the practice in the Canadian Society of Civil Engineers, the American Society of Mechanical Engineers and, we believe, in other organizations.

So far as the technical work is concerned, the organization of these local branches bids fair to solve one of the chief difficulties which has beset the national societies. A local engineering society always finds it difficult to procure a sufficient number of papers of real originality and merit to serve as a basis for its meetings during the year. The problem of the national societies is exactly the contrary. Their problem is how to have the papers which are offered to them properly presented and discussed at a meeting.

As a matter of fact, for at least twenty years neither the Institute of Mining Engineers nor the Society of Mechanical Engineers has had anything like adequate discussion of the papers presented before it. In the Mining Engineers, in fact, the great bulk of the papers have merely been read by title. In the Mechanical Engineers the necessity of crowding all the papers into two meetings a year has resulted in so brief time available for the average paper that the author who contributes a paper to this society often feels chagrined at the cursory attention it receives when it is presented at an annual or summer convention.

The organization of the local branches, however, enables any branch to take up for discussion papers which have been made available to it by the national society. It can in addition, of course, deal with such papers as it may obtain from its own local membership. It will often happen, for example, that a matter of particular interest in one city might come up with which the profession as a whole would have little concern. The local branch can deal with such a

matter much more advantageously than the national society. It is reasonable to expect also that a certain amount of friendly rivalry will develop between the different branches with respect to obtaining the best papers. Further, each branch is likely to bestir itself to secure new members for the national society in its own locality since thereby its own income will be increased.

We have now to turn to an entirely different aspect of the situation—the relation of these local branches of the national society to the local engineering organization. While the national societies have been growing apace, the local societies have not been standing still.

It must be said frankly that to the engineer who resides in one of the smaller cities, membership in the local engineering society offers to him in some respects more advantages than membership in the national society covering his branch of engineering. Not only this; but he may even get more actual benefit than a member of a national engineering society who resides in New York City. Most of the local societies offer many of the attractions of a social club to their members. The chances are that the member of the local engineering society in Pittsburg, for example, will visit his society headquarters a dozen times at least for every time that the average member of one of the national societies resident in New York City visits his headquarters there.

New York is so large a city that it is no longer possible to maintain in it social circles such as existed twenty-five years ago and such as continue to-day in the smaller cities. Old members of either the American Society of Civil Engineers or the American Society of Mechanical Engineers will appreciate that the headquarters of each of those societies in New York served as a social rendezvous twenty-five years ago in a way that is impossible apparently with the organizations as at present conducted.

There need be no thought therefore in the mind of any one that the local engineering societies can or ought to be superseded by the local branches of the national societies. What must be found is a way by which these local branches can cooperate with and perhaps form an integral part of the local engineering societies in various cities.

It is noteworthy that in some of the cities, Pittsburg, for example, the local engineering society has already divided itself into sections to deal with various branches of engineering work. One section is devoted to mechanical engineering, another to structural engineering, etc. It ought not to be a difficult matter, therefore, to in some way combine the local branch of the Mechanical Engineers, for example, with the mechanical section of a local society. To a considerable extent, the membership of the two will be identical; and if a way can be found by which the delicate matter of the non-eligibility of certain members to join the national society can be adjusted, combination should be perfectly practicable.

Viewed from a broad standpoint, we believe the broadening of the national engineering societies so as to make them really national by the organization of local associations of members is one essential to the greatest usefulness of all these societies. Under past conditions probably not more than one-third of the members of the national societies ever attend a meeting of the organization. Year after year they pay their dues and all they receive in return from it is the literature which the society publishes and the privilege of writing certain letters after their name.

This condition has existed so long because of the fallacious idea that the main purpose of an engineering society is to hold meetings, discuss papers and produce engineering literature. It is too often overlooked that the greatest benefit of an engineering society is to make men engaged in the same field of work acquainted with each other.

With this understood, the rest is easy. The members of the American Society of Civil Engineers resident in and around San Francisco have found that their informal meetings have made engineers personal friends who though living for many years in the same city and members of the same national society had never met. There is no reason why the 65 members of the American Society of Civil Engineers resident in Minnesota should not get together—a goodly proportion of them—in Minneapolis and St. Paul once or twice a year, in similar fashion, or the members of the Mechanical Engineers resident in Cincinnati and southern Ohio.

It is not by any means necessary for the success of these local branches that they shall hold meetings every month and learnedly discuss some engineering subject. Better a few infrequent meetings well attended and enjoyed than many kept up as a matter of form. It cannot be too often insisted upon that the societies exist for the benefit of the members. No activity of the society is worth while unless it does contribute in some way to the benefit of the members, the profession at large or the public.

There is still another development in connection with the national societies which is perhaps even more important than the organization of local branches. It will be apparent to any one who studies the list of engineering societies in this issue to what an extent specialization has been going on during the past quarter century.

The dream of those who organized the American Society of Civil Engineers was that it would be the one organization to which all engineers, whatever their field of work, should belong. There was, in fact, at that day hardly any mechanical engineering or mining engineering worthy the name, and electrical engineering was unborn. The organization of the other three national societies represented the first stage in the specialization of the engineering profession.

We are now, however, far past that epoch. Again and again it has happened that a number of engineers engaged in some special line of work, would meet together informally to talk over their various problems, would find the informal talk and the mutual acquaintance so pleasant and so profitable that the informal gathering would appoint a committee to arrange for regular meetings and for some form of permanent organization. This is about the way, probably, in which most of the engineering societies dealing with special lines of work have been formed. Most of them are proving themselves useful to their members or they would not continue to exist.

The organization of these special societies, however, is admittedly fraught with more or less danger to the national societies. In the field of mechanical engineering particularly there is little doubt that a great many engineers are now contenting themselves with membership in some society dealing with their special branch of work, who would otherwise join the national society which has to do with mechanical engineering in general.

The question arises, therefore, how can the national societies provide for the special needs of those of their members who are interested in special subjects? The situation has been met in the Mechanical Engineers by provision for the organization of professional sections, which deal with special branches of engineering work. The Gas Power Section of the society, for example, was organized some years ago and has been an active factor in the progress of gas engineering since that time. Its meetings are held at the same time as those of the parent society, but separate from it. Had this section not been organized, an independent Society of Gas Engineers would undoubtedly been formed.

It is extremely important to the welfare of the profession that facilities shall be afforded within the national societies for the development of special branches of engineering work. We strongly deprecate the undue multiplication of engineering societies. Their number is now so great as to constitute a serious tax on the members of the profession in both money and time. The multiplication of societies will be to a large extent avoided if the national societies recognize their responsibility to the profession and provide means by which engineers engaged in one special branch of work can meet to discuss common problems.

In the American Society of Civil Engineers, for example, there is opportunity for the organization of at least half a dozen sections to deal with special branches of engineering work. Such sections can be formed under the auspices of a national society with a minimum of red tape and of expense and can deal with technical matters of particular interest to a few, but which would be quite worthless to the average member of the society.

It is important to the interests of the profession, we believe, that development should take place along these lines rather than in the further multiplication of independent engineering societies. Many engineers find the demands on the pocket-book and on the time made by the numerous engineering societies of which they are members very serious indeed. If the specialization can go on within the national organizations with the aid of their machinery and finances, it should be possible to obtain the benefits without incurring a great burden of expense. Such a development would strengthen the national societies, instead of weakening them, and this also is extremely desirable, for, in our opinion, both the national and local organizations have more important work and greater responsibilities to undertake for the welfare of the profession than has yet been realized. But, as Kipling says, that is another story.

LETTERS TO THE EDITOR.

The Expansion and Contraction of Concrete During Setting, With Especial Reference to Cinder Concrete.

Sir: In Engineering News, July 6, 1911, p. 26, there appeared the paper by Professor White, of Michigan University, on the changes of dimensions in concrete during the processes of setting, drying out, and absorption of moisture. The subject is so interesting and important that all available data already obtained should be brought to the attention of engineers.

I would, therefore, call your attention to Bulletin No. IV., Vol. No. IV., December, 1909, of the Engineering Experiment Station of the Iowa State College, which contains a report of "An Investigation of the Change in Volume of Concrete During the Hardening Period," by C. W. Okey, and W. H. Leckliter. In this investigation, the changes in dimensions during the period of three months were measured in two directions, at right angles to each other, in the case of six concrete slabs, each 3 ft. square by 4 ins. thick, made of different materials and proportions. These slabs were kept in a room, exposed to the air, during the investigation.

In a general way the tests show that while ordinary concrete does contract in setting and drying out, yet in some cases, at least, cinder concrete may expand materially. In at least one case in Iowa this expansion of cinder concrete proved a matter of serious moment in construction.

A. Marston.

Iowa State College, Ames, Iowa, July 25, 1911.

A Proposal to Give Up the Street Surface to Railway Use.

Sir: In reference to your editorial and the articles on "Economical Freight Handling at the North River Water Front, New York City:"

The separation of railroad traffic from ordinary street traffic has a very important bearing on all plans submitted, and from present indications an elevated structure on West St. for this purpose seems the plan most likely to be carried out. Without going into the economics of terminal charges, which seem to be proved to the satisfaction of each side in the controversy according to the point of view taken, there still remains the question, in the event of building an elevated structure, whether it would not be more economical to maintain the railway tracks at the present street surface and use the elevated structure for trucking purposes.

This would mean a much lighter structure, with longer spans and fewer columns, render the arrangement of tracks more elastic, and give better access to piers and car floats, while at the same time preserving good light and air for the street traffic. Access to such a raised street

could be given for trucks every four to six blocks by a ramp of easy grade which would not interfere with traffic in the side street used, as that street would end at this point and so have little traffic except that destined for the elevated structure. Access for pedestrians could be provided for at every street.

The number of passengers carried on ferry boats is already much reduced since the completion of the river tubes, and facilities are provided for those remaining on the upper decks of almost all ferry boats. Ramps of easy grade parallel to the elevated street would give trucks access to the ferries, those trucks going off the boat taking one ramp, those going on taking the other.

As the city owns the water front and the present street surface, it could lay out a much more comprehensive track system at considerably less expense than the system proposed by Mr. Tomkins entails, and a consequently smaller charge to the railroads availing themselves of the terminal facilities offered.

Chas. S. Wray.

Highland Mills, N. Y., July 17, 1911.

[The construction of elevated pedestrian walkways in the most crowded parts of cities, leaving the present street surface for vehicle and street-car traffic, has long been contemplated as a future possibility. The scheme suggested in the above letter might be suitable in conjunction with such a system. Alone, however, it could be made to fit the requirements of the West Street water front only by very extensive and costly construction and re-arrangement.—Ed.]

On Specifications for Steel Bars for Concrete Reinforcement.

Sir: The "Standard Specifications for Steel Bars for Concrete Reinforcement," proposed by the American Society for Testing Materials, as printed in your issue of July 20, contains a "joker."

Under the heading "form of specimens," the specifications read:

6. (a) Tensile and bending test specimens may be cut from the bars as rolled, but tensile and bending test specimens of deformed bars may be planed or turned for a length of at least 9 ins. if deemed necessary by the manufacturer in order to obtain uniform cross-section.

The main purpose of testing is to determine the physical character of material used, and in the case of material that is to be used in the form in which it is rolled, should not the tests be made on that form? Many claims are made that certain deformed bars have a so-called constant cross-section and the same elastic limit and tensile strength as plain bars. The usual case is that there is a measurable difference. For illustration, from published tables of bars a designer finds:

Plain 1-in. square bars, section 1 sq. in. weight	3.40 lbs.
Deformed 1-in. square bars, section 1 sq. in., weight	3.43 lbs.

The designer therefore may decide to use the deformed bar and calculate that he will have 1 sq. in. area of steel stressed to the allowable unit. He expects the one inch of steel weighing 3.43 lbs. per ft. to develop an elastic limit of say 50,000 lbs. Competition will insure that the bar will overrun but little if any in weight and therefore it stands to reason it will be important to know whether that particular bar will have an elastic limit equal to what is expected, or whether the deformations increase or decrease the elastic limit.

It is a fact, that, pound for pound, deformed bars have a lower elastic limit than plain bars. This refers to bars rolled with irregular surfaces and not to cold-twisted bars.

The writer believes in the use of deformed bars and in an elastic limit of 50,000 lbs. or more per sq. in. He also believes that a small excess of steel must be added to the volume of a plain bar to obtain a deformed bar that will develop a greater bond strength than a plain bar, but he does not believe in a technical society endorsing a specification which contains a "joker."

All forms of deformed bars should be tested as rolled and their actual elastic limit and ultimate tensile strength given. To determine these properties per square inch of section, the actual results should be divided by the nominal area, or the area of a plain bar of the same weight per foot. The elastic limit of such bars may be 10% or 15% below the elastic limit determined from specimens planed or turned to a uniform cross-section.

The writer's practice is to specify that the bars shall be tested in their finished form and that mechanical-bond bars shall have the same effective area as plain round or square bars.

Regarding twisted bars, it is usual to require that there shall be one complete twist in a length equal to eight times the thickness of the bar, instead of twelve times, as proposed.

The proposed allowable variation in weight of 5% is twice what is allowed on structural shapes and seems entirely unnecessary except to cover excess weight on deformed bars.

Yours truly,

T. L. Condron.

Monadnock Block, Chicago, July 21, 1911.

[A misleading error of the printer's devil made the title of the specifications, as printed in part of our edition, read "Proposed Standard Specifications for Steel Turn Bars for Concrete Reinforcement." The word "Turn" should of course be omitted.—Ed.]

Vitrified Clay Pipe for Pipe Lines in Alkali Soil.*

Sir: In Mr. Zenas N. Vaughn's account of the selection of materials and designs for a pipe line in Idaho, which appeared in your June 29th issue, I see an illustration of a very common, but none the less amusing, tendency of engineers to interest themselves in the newer materials of construction to the exclusion of old-fashioned ones. I do not exclude myself from this commentary, but am quite willing to admit that it is more fun in my own work to engineer a clever or novel piece of construction than one of the old cut-and-dried variety.

In investigating the relative merits of materials for constructing a pipe line to carry water under a 70-ft. head through an alkali slough, Mr. Vaughn considers only three rather modern types of construction; where "strength alone decides the choice," he says, "the order would probably be riveted steel, wood stave, concrete; for discharge capacity, wood stave, concrete, riveted steel; for durability, concrete, wood stave, riveted steel." So far so good; but, as long as he was investigating, why did he fail to consider that good old standby, vitrified glazed clay pipe?

The only reasons for not considering this old timer would be a doubt as to its ability to stand the pressure of a 70-ft. head, and the fact that it is too old-fashioned to be interesting. A 70-ft. head is equivalent to 30⅓ lbs. hydrostatic pressure per sq. in. Comparing vitrified clay pipe with the material which was finally chosen for the job, in respect to its ability to withstand that pressure, it is interesting to turn to the report of Brooklyn's Bureau of Sewers, as published in the "Municipal Journal and Engineer" of Feb. 2, 1910, and to read some of the paragraphs therein. For instance, speaking of the quality of 42-in. clay pipe furnished the borough of Brooklyn, Engineer Fort found "the strength developed under the usual crushing test greatly exceeded expectations * * * I am confident that * * * it will be demonstrated that, where it is essential that the sewer should be water tight and the inflow of ground water is large and under considerable head, the use of pipe of this character * * * is economical and produces better results, even though the first cost of such pipe is high."

And further, "Percolation through vitrified pipe, such as is used in this borough, usually commences at a pressure of 5 lbs. per sq. in., equivalent to a head of water 11.5 ft. It increases very slowly as the pressure increases to the point of bursting, which is usually at above 40 lbs per sq. in.

A table showing the comparative amount of voids in the two materials, as expressed by the absorption of water, gives as an average of 584 tests on the vitrified pipe an increase in weight by absorption of water, 3.9%, while the average of 18 tests on cement pipe gives 6.83%.

Brooklyn's Kosmocrete pipe is admittedly the best concrete pipe ever made in this country; yet, according to Brooklyn's engineer, it is not equal to the good, old-fashioned vitrified pipe for holding water under pressure.

Similar absorption tests were conducted in parallel by Mr. C. P. Bliss, Director of the Testing Laboratory of the University of New York, and showed that, while vitrified pipe began to show sweating or dripping at 12 lbs. pressure and refused to break at 90 lbs., concrete pipe soaked in small streams at 6 lbs. and broke at 4[illegible] lbs.

In a recent test conducted by Burns & McDonnell, engineers, of Kansas City, to show the comparative merits of vitrified clay pipe and various makes of concrete pipe, and at the same time to try out the new methods of testing proposed by the Iowa Engineering Society,* a 12-in. standard vitrified clay pipe appeared at a decided advantage when compared with a 12-in. Kosmocrete pipe from Brooklyn, a concrete machine-tamped pipe from Tacoma, Wash., and a hand-tamped 12-in. concrete pipe made under the supervision of the Government engineers at Nampa, Ida. Standard vitrified pipes 27 and 30 ins. in diameter showed to even greater advantage when compared to the best make and design of reinforced-concrete pipe. In all these cases the vitrified clay pipe showed a greater crushing or bearing strength as a whole, and a far greater modulus of rupture for the section.

The Kansas City Testing Laboratory, testing fragments of these same pipes for absorption, found that concrete specimens absorbed proportionately from 10 to 20 times as much water as the vitrified specimens.

It appears to me from these data that Mr. Vaughn's investigations might have included at least four materials of construction, arranged somewhat in the following order:

Where strength alone must decide the choice the order of preference would be riveted steel, wood stave, vitrified clay pipe, concrete pipe; for discharge capacity, vitrified clay pipe, wood stave pipe, concrete pipe, riveted steel; for durability in the presence of alkali, vitrified clay pipe, wood stave, concrete pipe, riveted steel. It must be admitted that 30 lbs. pressure is a high one to put upon either vitrified clay or upon concrete pipe without additional strengthening; but since costs were not the first consideration of this investigation and subsequent installation, it seems that a vitrified pipe could have been used alone for a large portion of the line, and on the lowest part of the line it could have been strengthened by an outer envelope of heavy reinforced concrete.

This would have given a maximum discharge for the diameter of the pipe; and, since concrete is not usually affected by standing water, but by water percolating through it, this combination would have proved the maximum insurance and guarantee of the lasting ability of the installation; for the vitrified pipe lining would not only have acted as an inside form for the concrete, thus bringing its cost lower than usual, but would have provided an impervious layer to prevent water from passing the concrete in either direction. The owners of this project would thus have had far greater opportunity to sleep nights without anxiety, than that given them by a few months' trial on a specially made length of concrete pipe merely laid in alkali water, but not subjected to its percolation under a head.

Benjamin Brooks.

1720 Jefferson St., Kansas City, Mo.

*References to the use of vitrified clay pipe for water conduits are as follows: Engineering News, Jan. 17, 1901, p. 46, describing a 24-in. conduit 16,700 ft. long in Hartford, Conn.; Feb. 21, 1901, p. 137, a letter by Mr. F. E. Trask, M. Am. Soc. C. E.; May 21, 1896, p. 341, giving results of 108 tests to determine the water-tightness of a pipe line in Peoria, Ill.; Oct. 24, 1895, p. 283, describing an installation at Little Falls, N. Y.

The Bridgeport Wreck and Automatic Stops.

Sir: Your editorial in the issue of July 20, entitled "The Bridgeport Wreck and Automatic Stops to Supplement Railway Signals," strikes the nail so squarely on the head in the sixth paragraph that it will stand repeating here:

In view of all these facts, attention ought to be concentrated on one single question: What can be done to safeguard trains against the passage of danger signals? Other questions which came naturally to mind when the first incomplete accounts of the wreck were received are beside the mark. The safety of trains on every mile of their journey depends on the engineer's obedience to signals. Is there any practicable means by which a train can be saved when the engineer fails to apply the brakes at the proper time and bring his train under control?

That is the question: What can be done to prevent running past signals when the elements interfere and negative human vision, when the engineman is dead or physically incapacitated, which too frequently happens, as well as when, from a desire to make time or other cause, chances are taken.

In the consideration of this all-important question we can ignore the hazy historical state-

*Eng. News, March 2, 1911, p. 259; May 18, 1911, p. 609.

ments contained in your editorial; but we take exception to the very general accusation of the inventors' "ignorance of railway operating conditions." All inventors are not so extremely ignorant of operating conditions and inventors have no corner on such ignorance.

The conditions, stripped of all technicalities, are as follows: To obtain practical automatic control of trains the stop must be applicable to present standards of roadbed and rolling stock and conform to all standard clearance requirements. It must operate to apply the brakes when the stop signal is disregarded and also to compel the requisite reduction of speed when the cautionary signal is displayed and it must always apply the brakes when a false clear indication is given by the signal. So much for the automatic stop. The system as a whole, i. e., a block signal system embodying automatic stops should not only protect trains one from the other but should protect all trains against broken rails, misplaced switches, open drawbridges, sidetrack fouling points, etc.

On single track it must indicate direction to the extent of inhibiting all opposed trains between adjoining passing tracks and at the same time permit following trains to the full safe capacity of the road and of course it must be operative in all kinds of weather.

This means ample automatic protection against all errors of the dispatching system, such as lap orders, the forgetting or misreading of orders or failure to deliver orders. In short, trains cannot proceed beyond the limit of safety, orders or no orders. All necessary train movements, switching, etc., can be done with safety, the meeting and passing of trains facilitated and the capacity of the road thereby increased. The train crew must never be left in doubt, the system must indicate, when the train is stopped automatically, whether it was because of a danger signal displayed or a cautionary signal displayed or a false clear indication which caused the stoppage.

Cab signals are not considered herein, because one of the conditions is protection to the train with a dead engineman and it is obvious that a cab signal cannot provide such protection.

It is conceded that an inventor to be able to design apparatus to meet the above conditions should have, in connection with his mechanical skill, a knowledge of standard rolling stock and roadbed, understand the working of air brakes and in fact, should be a good operating man.

It may be that some inventors in "guarding against one danger * * * have introduced greater ones" but your illustration is unfortunate. It is only necessary to go back to the introduction of the air brake, which we can all remember. Train men prior to that time were very skilled in the use of hand brakes and could control trains under most trying conditions. The same argument that you are now using was made against the air brake, viz.: The brakemen will become careless and incapacitated, through depending on the air brake, and then when it does fail they will be unable to stop the train.

This argument applied with far greater force to the air brake than it possibly can to the automatic stop because the air brake not only prevented the trainmen from getting the practice which made them proficient in the use of hand brakes, but it overloaded the brake rigging to such an extent as to render futile any attempt they might make to get the brakes effectively to the wheels by hand. Notwithstanding all this the air brake prevailed, but to a limited extent only until Congress compelled its universal adoption.

Following your illustration, above referred to, you state "It is not a mere matter, as the public suppose, of appropriating so much money and buying safety devices as one would buy frogs or spikes or train brakes."

On the contrary: It is a mere matter of purchasing safety devices the same as other commodities, so far as the safety device is concerned. There is apparatus to be had that has been fully tested and has demonstrated its ability to meet all operating conditions and provide the complete protection above set forth. The reports of the Block Signal and Train Control Board, stripped of their superficial confusing verbiage, verify this statement.

Talk about the ignorance of inventors "creating new and greater dangers"! The most harebrained invention that ever was presented could not introduce as great danger to the same operation of trains as would the complete list of characteristics set forth by the Block Signal and Train Control Board, if they were fully inaugurated.

It is a fact, clearly within the memory of railway men of that time, that when Congress passed a law compelling the use of power brakes on freight trains, the highest development in the art of power brakes was totally inadequate to meet the conditions of freight service and train after train was actually wrecked by the brakes; but opportunity was provided and the Westinghouse Co. developed their brake until it meets the conditions and has become indispensable.

The automatic control of trains has reached a higher state of development than had the power brake at the time the law compelling its use was passed. Not that automatic control apparatus is perfect. Improvements will continue to be made and when its introduction is once started improvement will be rapid; but it has reached that stage of development where its introduction will not be attended with a long list of accidents because of its inability to meet conditions as was that of the air brake.

Your suggestion that a company or organization under the control of the American Railway Association take the matter in hand is good; and there is no question but such an organization could be of inestimable value in the development and introduction of such apparatus.

When the long list and constant increase of railroad casualties are taken into account, there arises a consideration of far more importance than any monetary remuneration for an invention; and some inventors who are not altogether ignorant "of railway operating conditions" are broad-gage enough to give some consideration to the humanitarian side of the question.

B. C. Rowell.

470 The Rookery, Chicago, July 27, 1911.

[We did not intend to accuse *all* inventors of safety appliances of ignorance concerning railway operating conditions. The fact that some of the automatic stops have reached the stage of practical application is in itself proof that some inventors have thoroughly studied the conditions their devices must meet. Any inventor, however, will be benefited and aided by the cooperation of the railway officers most familiar with practical requirements; and the chief aim of our editorial was to urge that such cooperation, financial and technical, should be furnished.—Ed.]

The Relation Between the Fire Loss and Politics in Municipal Fire Departments.

Sir: The space given in recent issues of Engineering News to papers written on fire protection subjects and to details of unusual fires, indicates a growing interest in such matters among engineers. There is abundant justification for this in the essays and addresses mentioned; notably in the statement by the Secretary of the Interior that the annual per capita fire waste in the United States runs about $2.50, while in six leading European countries it is 33 cts.

It is within bounds to say that the whole proposition of preventing and controlling fires is an engineering one with its scope developing rapidly, and now including all branches except the actual extinguishing of fires too large to be termed incipient.

During the past 15 years great progress has been made along the lines taken up by engineers, but not nearly so much in the "putting out" of fires. We know how to plan a structure for any purpose and have it safe as against fires within or without; we can also arrange to retard or even check a fire before its outbreak has been noticed. There is an increasing number of buildings that range from slow burning to reasonably fireproof, and such conditions in general are decidedly improved.

Yet our towns and cities are filled with fire traps of every kind and upon these the splendid work of the experts has made small impression. Their owners still get insurance at rates which apparently justify maintaining them. Moreover, some of those conflagration breeders were called fireproof until it was demonstrated that large floor areas, piled high with inflammables, are not rendered secure by incombustible exterior walls. Against hazards of this kind such organizations as the National Fire Protection Association have fought manfully, but at frequent intervals one of these kindling piles bursts into a volcano of flame and then the methods available for saving adjacent property are generally the same as 15 years ago. The number of fires and the amount of losses still increase steadily.

For some reason not understood, there is very little discussion of fire departments when experts get together; yet they are still the largest factor in fire protection. That they would be a small one could intelligent and scientific building methods prevail and all fire traps be torn down or remodeled, is naturally true enough, but we are dealing with conditions and not theories. The finances of nearly every city are strained to the limit to maintain fire departments in which men are on duty practically 21 hours out of every 24, and yet some of the best work of the prevention experts has been expended in merely giving the firemen a fighting chance.

A dangerously large proportion of fires are kept from becoming conflagrations only by intelligent and strenuous work by large forces of firemen, with the aid of an ample water supply, powerful engines, plenty of other apparatus and a certain amount of good luck. Very often the margin of safety is distressingly small.

There are many contingencies that may turn the scale and among these can be cited delays in giving the alarm, storms or high winds, explosive conditions as in the Baltimore fire, extreme heat or cold, frozen hydrants, mains shut off or burst, disabled engines or machinery, several fires at one time, a demoralizing accident or work that is strenuous but not intelligent.

Of course these things either should not happen or might be properly provided for, but the human element enters into this and the best possible fire organization is at times dependent to some extent upon other departments over which it has no control. In a substantially constructed and well safeguarded building in a European city the details of handling a fire cannot be of such vital importance, but in the case of a burning American fire trap a mischance which may be almost unavoidable may easily cause disaster.

Matters of this kind have not yet had enough attention from the experts, although the firemen realize their importance. One may search in vain through the voluminous reports gotten out after a great conflagration, for any information as to the actual work of the fire department, which ought to be the first consideration.

For many years before the Revolution, the men in charge of New York's fire engines were called "engineers," the man at the head naturally becoming the "Chief Engineer." In recent times this has been properly changed to "Chief of Fire Department," which is now the more common title. This official has direct charge of the extinguishing of fires and commonly has a Commissioner or Board of Commissioners over him, who are a help to him if they are not politicians. Like the City Engineer, the Chief finds politics the greatest obstacle to efficiency.

The National Board of Fire Underwriters seems to recommend that the office of Fire Commissioner be created in such cities as are without it, and asks that this official be given a place and proper prestige in whatever Board does the public work. This is most commendable, but they should go further and insist that he be not also the head of the police, for this latter is one branch of the government that few mayors ever try to keep out of politics and if coupled with it the fire service is bound to suffer.

The position of Fire Commissioner offers a promising field for a public spirited civil or architectural engineer, because he is best prepared to cope with the fire prevention and hydraulic questions that may arise. He would also find the work of the fire department of absorbing interest. Nearly every one of our American cities needs the services of such a man in that capacity, and there will not be much improvement in the fire situation until less attention is paid to politics and more to the securing of competent department heads. Witness what was accomplished by Rhinelander Waldo in New York in spite of politics.

The office of Chief of the Fire Department is an anomalous one in America, with nothing like the standing it has abroad. The official who fills it certainly has the public esteem, but mainly for the rough and ready work of putting out fires. By reasons of personality and possibly more or less talent as his own press agent, he may become a great popular hero; but even then it does not follow that he gets much consideration as an expert in his specialty. Few seem to think that the experience gained in extinguishing fires should be the best teacher of how to prevent them.

If this real or pretended lack of confidence is due to the Chief not having the advantages of a technical education, it is an argument in favor of a competent commissioner. But many times the proof has been literally burned in that a proper regard for the advice of the fire chief would have prevented, or at least mitigated a great disaster.

As yet engineering experts have concerned themselves with the work of fire commissioners and fire chiefs to a very limited extent, in spite of the ever increasing losses and repeated disasters. There can be no reason for this but recognition of the blighting effects of politics. One instance of engineering interest is the series of fire department inspections by the experts of the National Board of Fire Underwriters, which have been of benefit in all cases where doubt was not cast upon them by the claim that the engineers were without practical experience. In a politics-ridden community it is doubtful if the powers that be would pay attention to any kind of an expert, unless the latter had experience in the art of impressing such people.

Doubtless many on reading this communication, will wonder why politics is mentioned as such an important factor. There may be some who do not realize that a very large proportion of the destruction by fire of human

life and property in this country is indirectly due to politics alone.

Engineering News often contains stories of the unusual experiences of its readers and some interest may be taken in the tribulations of one who was a pioneer in the ideas with which this article is mostly concerned. The facts stated are absolutely true; whether disaster followed from them may depend upon the point of view, but at any rate they form an excellent illustration of the practical workings of politics in fire matters.

Five or six years ago an individual who would be remembered as a "fire crank" by his fellow members of the class of '82, at Illinois University, was concerned in reorganizing the fire department of a city of over 200,000 population. He had harbored an old-fashioned enthusiasm about fires all his life and made the handling of them a study besides interesting himself in improvements. In smaller towns he had been a volunteer fireman in the days when he was a city engineer, and he was thoroughly familiar with the larger departments of the whole country.

The Mayor, who was of the opposite political party, asked this engineer one day to take charge of the department and to act as both commissioner and chief, since the charter provided only for the latter. This proposition was at first declined, but after two weeks' consideration it was accepted, somewhat as a public duty, especially as the Mayor guaranteed that there would be no politics in its conduct. After passing the Civil Service examination, which was severe but fair, the incumbent could be removed only on the proving of sufficient charges.

During the terms of the two Mayors, the Chief kept himself out of politics and politics out of his department. The fire losses ran low and there was no evidence of dissatisfaction within or without. The work as commissioner and the details of department management were enough to occupy his days and until nearly midnight of his evenings. In addition the Chief was in active command at every fire of consequence. He had charge of the fire protection of an exposition and came through with the lowest loss on record in spite of extreme hazards.

About 13 months ago, the administration changed and the new Mayor removed the Chief the very day he took office. There was no effort to conceal the fact that it was for "political reasons." The man appointed to his place was a fireman, but not in a position where such a promotion might be expected. He had formerly driven an express wagon but luckily could read and write; he was chiefly distinguished for doing political work directly contrary to Civil Service rules.

The ex-Chief having had no chance to resign, appealed to the Civil Service Commission as was his right under the City Charter. Of course he knew there was no chance to serve under that Mayor, but he wanted to clear himself before getting out. The reasons or "charges," set forth by the Mayor as the law required, contained nothing as to incompetence or moral turpitude, nor was the Chief accused of having engaged in politics. The evidence submitted against him at the trial was given reluctantly and related mainly to such matters as an alleged failure to answer certain letters and disrespect shown some city official; it was not taken seriously by any one except those who were determined to put a political worker into the office. But the Commission sustained the Mayor, evidently remembering the latter's public declaration that he would force his way with appointments if he had to have a new Civil Service Commissioner for breakfast every morning. The fact that a favorable report had just been made on the fire department after a two months' inspection by the experts of the National Board, of course availed nothing.

This particular city has a recall provision in its charter and by the use of this the Mayor was retired to private life within a year. The vote indicated that a majority of citizens believed in the existence of a conspiracy to "graft" on vice and crime. A grand jury was called and indictments followed. The new Mayor removed the fire chief with other officials, and then declared his intention of appointing the victim of the trickery of the year before. But a majority of the Civil Service Commission were the same ones who had sustained the charges at that time, and they announced that when a person was once dismissed for "good cause," he could never be given an examination again and therefore would draw no salary. The Mayor gave up in the face of this blacklisting, and at last accounts was endeavoring to secure a chief in New York.

There is scarcely a city in the United States where the fire service has not been made the plaything of politicians in some such fashion as this. Civil Service, and other Charter safeguards, are a protection only when controlled by men who think first of efficiency and last of politics. Unfortunately, very few people know anything about these matters, even in their own cities, and fire departments get very little attention from those who are either public spirited or heedless. Every case of this kind should have publicity so that eventually there may be a popular understanding of one of the chief obstacles to efficient municipal fire service.

Harry W. Bringhurst.

Seattle, Wash., June, 1911.

Prevention of the Electrolytic Destruction of Reinforced Concrete.

Sir: My attention has been called to an article, in your issue of June 8, by Mr. H. P. Brown on the injury to a reinforced concrete building by electrolysis. As an electrical engineer I am surprised at some of the statements in this article.

The author states in effect that current flowed from one side of the direct current circuit into the enclosing conduit, through a portion of this conduit, through metal hangers, into the concrete, through the concrete, through the metallic structure, through the concrete again, through more hangers, through a portion of another conduit, and back into the other side of the circuit. It is evident that the resistance of this path must have been considerable.

Rule 25, of the National Electric Code, paragraph "f," provides that all metal parts of a conduit system must be electrically connected together and grounded. If the conduits in the case above described had been all well electrically connected together, there could have been no possibility of sufficient current to produce bad effects leaving the perfect electrical path presented by the conduit system and passing through the high resistance path of the building structure.

This simply goes to show that the fault does not lie in the system of wiring even though it is admitted that it was a troublesome piece of wiring on account of the moisture. The fault lies with the supervising engineer and the Underwriter's Inspector who appear to have failed to do their duty in not seeing that the system was installed in a proper manner and as provided in the Rules.

The author further says that it is evident that there can be a leakage through the concrete without operating the ground detector in the distant engine room. Furthermore, he says that there might be dangerous leakage through the detector unseen. If the conduit had been installed as provided for in the rules, it is a physical impossibility for any dangerous leakage from the wires to take place without showing on the ground detector, assuming that a standard lamp detector is meant. In the second place there could not be a dangerous leakage through the detector unseen because, if the detector were built with ordinary size lamps, a small fraction of an ampere would show up immediately. Such a small current could not do much harm in a building in a short time, particularly when it would go through the conduits instead of the building itself.

The recommendation No. 3, at the close of the article is one which cannot be too highly condemned. The use of a ground detector which is not continuously indicating is a menace instead of a safe guard because the engineer often forgets to see whether there are any grounds and, what is more important, grounds frequently appear and disappear again, and may not be in evidence at the moment the system is tested. The engineer may therefore be resting in a fool's Paradise under these conditions. The safe way is to install a perfect conduit system and put in a good continuous indicating ground detector and then watch the ground detector.

I agree with recommendations Nos. 2 and 4, because if they are not complied with, no ground detector can be installed. Recommendation No. 5, may be all right and may be necessary to provide against electrolysis from exterior currents but it is unnecessary in providing against electrolysis from a properly installed conduit system in the building itself as was the trouble in this case.

Yours very truly,

B. G. Worth,

181 Watchung Ave., Plainfield, N. J., July 19,'11.

[Mr. Brown has made the accompanying comments on the foregoing letter.—Ed.]

Sir: I see from Mr. B. G. Worth's letter of July 19 that I did not make clear some details in my article printed in your issue of June 8. He is mistaken in his belief that the trouble was caused by failure to comply with the Underwriters' rules, since the electrical plant in the building in question was carefully installed in strict accordance with the National Electrical Code of the Board of Fire Underwriters. It passed their inspection when completed and has been reinspected at various times without criticism. Their code was designed to avoid danger from fire and has of course been changed from time to time to meet new conditions. It has not been their duty to design methods of protecting steel reinforcement or foundation plates and bolts from electro-chemical injury. If it becomes necessary to modify some of their rules to obtain such protection, it is certain that reasonable changes will be carefully and conscientiously made.

Mr. Worth seems to believe that "grounding" is a sovereign remedy, for he writes:

> If the conduits in the case above described had been all well electrically connected together (and grounded) there could have been no possibility of sufficient current to produce bad effects leaving the perfect electrical path presented by the conduit system and passing through the high resistance path of the building structure.

Had he read my article carefully, he would have seen that the conduits are "well electrically connected together," and that they are also grounded every 8 or 10 ft. with metal having many times the conductivity of the conduit. This was one cause of the trouble, not the cure!

He expresses surprise at some of the statements concerning the electrical conditions in the building. He could not be more surprised than was the writer when the remarkable conditions were actually encountered. The electric-light conduits are made of light japanned steel, mainly of ½-in. size, weighing when new about 0.82-lb. per ft. Its conductivity in unbroken lengths would be less than that of a No. 6 B.W.G. copper wire. In the damp portions of the building the joints and pipes are badly rusted and cannot possibly afford the "perfect electrical path" which Mr. Worth feels they should present. Nor can the rubber-covered, triple-braided insulated wire, required by the Underwriters' Code in 1906, withstand indefinitely the attacks of heat and cold, steam, vapor, acid fumes, salt and ammonia.

If one should take a pair of electric wires with the insulation just described, place them in a thin steel conduit with rusty joints, fasten the conduit every 8 or 10 ft. with heavy iron clips and ¾-in. bolts to large iron sockets and clamps holding four to six steel rods 1-in. in diameter, and then immerse the entire system in a tank containing a solution of acid and water with more or less ammonia and sodium chloride, a condition would be produced which would resemble that presented in parts of the building. If the wires were connected to the poles of a direct-current dynamo at 120 volts and the tank were supported on brick walls, it is evident there would be a heavy current flow through the tank system without operating a "ground detector" in a distant engine room; nor would the detector operate should there be two heavy grounds equally divided, as is well known to every one familiar with the principle of the three-wire system.

It should also be evident that the iron clamps and the steel rods in this tank system would be electrically charged and that this charge would be positive as compared with the negative wire. Therefore the metal surfaces submerged in the conducting fluid would become covered with bubbles of nascent oxygen with more or less active acid. The surfaces would surely be corroded and if surrounded with concrete the concrete would sooner or later be forced apart. I trust that this will make it clear to Mr. Worth that grounding caused a part of the trouble and that more grounding would only make it worse.

Referring again to his letter, he seems to believe that saturated concrete with heavy reinforcing bars directly supporting a network of overhead rails and large steam, water, ammonia and drainage pipes cannot compete in electrical conductivity with an insignificant iron conduit weighing less than one pound per foot. On the other hand, an editorial appearing in the "Engineering Record" of July 8, considers this same mass such a wonderfully efficient conductor that it leads a stray railway current to enter the cellar from the street on a 1¼-in. pipe and with 3¾ millivolts pressure, to climb to the third story, to somehow leave the pipe without electrolytic injury and then get on to the structure and return downwards with its full strength of one ampere, inflicting great injury to several thousand square feet of concrete on its way, without indicating its path to the power house!

I wish to say to my disagreeing critics that under certain fair conditions I will gladly arrange to take them to the building and let one of them isolate what he believes to be the destructive railway current and permit the other to demonstrate the "perfect electrical path" presented by a rusty ½-in. conduit.

As a part of my scheme of protecting the reinforcing steel in the building I am insulating the conduits and carrying heavy testing wires from them to a "Leakage Detector" in the engine room. This is left permanently in circuit and

represent the first line of defence, and Mr. Worth is correct if he means that such a test should be continuous. A single wire then grounds the entire conduit system through a known resistance and in this circuit a "Ground Detector" is applied mechanically at regular intervals. The first detector will show immediately any leakage from the electric circuit to the conduit; if this indication is not heeded, the second detector will show any subsequent leakage from the conduit to the ground and start an alarm which will force the attendant to make the necessary corrections. If stray currents from outside the building are then shut out by insulating water and gas pipes, etc., at foundation walls, the metal work of the building can be easily protected by suitable devices.

I feel very strongly that grounding the "neutral" wire in the three-wire system should be prohibited since there have already been cases of injured foundation plates and bolts of steel structures caused by this practice. The destruction of the steel sub-structure of our skyscrapers is not a pleasant subject to consider, but we cannot escape it unless we modify or abandon some of our present methods of electrical distribution and use efficient protective devices which can be easily applied in new buildings. Some engineers believe protection is secured by attaching ground wires to the foundation steel. Cases have occurred, however, which show that this is not effective.

Above all, it is important that the foundation structural steel should rest upon and be surrounded by absolutely waterproofed concrete of high electrical resistance.

Harold P. Brown.

120 Liberty St., New York, July 26, 1911.

Notes and Queries.

Mr. Edward Godfrey writes that an error in printing his letter, "The Hamburg Gas-holder Failure," p. 119 of our issue of July 27, 1911, obscured the meaning. The first sentence of the second paragraph was meant to say that the ultimate strength of the column was somewhere between 66,000 and 133,000 (not 263,000) lbs. The fact that the column gave way under an estimated load of precisely the latter amount, 133,000 lbs., is the "very nice practical demonstration of theory" mentioned at the end of the paragraph. The calculated capacity of 133,000 lbs. is based on an effective pin-end length of 7/10 the total length, and the true ratio of slenderness of the post.

Statistics of Railways in the United States for the Year Ending June 30, 1910.

The figures in the accompanying table are arranged from a "preliminary abstract" of the Twenty-third Annual Statistical Report of the Interstate Commerce Commission, issued by the Commission. It is reported that revised returns may slightly affect some of the advance figures obtained. The data apply to the year ending June 30, 1910.

An increase of mileage, exceeding 100 miles, appears for Arizona, California, Florida, Georgia, Minnesota, Mississippi, Nevada, Oklahoma, Oregon, Texas, Washington, and West Virginia. Of the total mileage of line reported, 10,357 was used under trackage rights. In addition to the 2,196 companies for which the data applies, there were 301 switching and terminal companies reporting to the Commission, showing 1,614 miles of main track and 2,271 miles of yards and sidings—3,885 miles in all.

The figures for car equipment do not include so-called "private" cars of commercial concerns. Of the 2,349,278, cars and locomotives, 2,301,260 were fitted with train brakes and 2,332,837 with automatic couplers. These figures show increases of 86,353 and 72,060, respectively, over the previous years. Nearly all passenger equipment and substantially all freight locomotives had both fittings. Of the 2,135,121 freight cars in use, 2,107,312 had train brakes and 2,120,750 had automatic couplers.

The total number of railway employees have been distributed in another way from that shown in the table (omitting 95,328 not distributed).

Maintenance of way and structures	504,979
Maintenance of equipment	329,273
Traffic expenses	21,652
Transportation expenses	661,355
General expenses	53,385
Outside operations	33,348

There were 33,015 persons employed by the switching and terminal companies of June 30, 1910, having a total wage of $21,719,549.

The figures for revenues exclude returns from a few small roads on account of deficient reports. The fifth item of revenue, other than freight, passenger, mail and express, includes items like excess baggage, milk on passenger trains, parlor-car seats, switching, special train service, operations other than transportation, joint facilities, etc.

In the data on income, profit and loss operating and leased roads are grouped separately. It is evident that the operation of the leased roads is included in the results of the operating roads, the accounts of the former being largely confined to receipts and payments under contracts and agreements. For the aggregates of items like taxes accrued, disposition of corporate income aside from dividends, surplus (profit and loss credits) it is evident that the sum of the separate figures must be taken to apply to the railways of the country as a whole.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1910: INTERSTATE COMMERCE COMMISSION.

Mileage.

Number of railways reported on		2,196
Total miles of line		240,831
Increase for year		3,605
Total single track	240,831 miles	
" second track	21,659 "	
" third track	2,206 "	
" fourth track	1,489 "	
" yard and siding	85,582 "	
Total miles track		351,767
Increase for year		9,415

Equipment.

Passenger locomotives	13,660	
Freight locomotives	34,992	
Switching locomotives	9,115	
Unclassified locomotives	1,180	
Total locomotives		58,947
Increase for year		1,735
Passenger cars	47,095	
Freight cars	2,135,121	
Company service cars	108,115	
Total cars		2,290,331
Increase for year		72,051
Av. loco's. per 1,000 miles line		245
Av. pass. cars per 1,000 miles line		9,510
Pass. miles per pass. loco		2,367,386
Ton-miles per freight loco		7,287,863

Employees.

Enginemen	64,691	
Firemen	68,321	
Conductors	48,682	
Trainmen	136,938	
Switchmen, etc	44,682	
Total		1,699,420
Increase for year		196,597
Av. per 100 miles line		706
Total wages		$1,143,725,306
Av. wage		674

Public Service.

Passengers	971,683,199
Increase for year	80,210,774
Passenger miles	32,338,496,329
Increase for year	3,299,173,740
Pass. miles per mile road	138,259
Tons freight	1,849,900,101
Increase for year	293,340,360
Ton-miles	255,016,910,451
Increase for year	36,213,923,522
Ton-miles per mile road	1,085,745

Revenue.

Freight	$1,925,553,036	
Passengers	628,992,473	
Mail	48,913,888	
Express	67,190,922	
Other	80,017,116	
Operating Revenue		$2,750,667,435
Av. revenue per mile line		$11,607
Receipts per passenger-mile		1.938 cts.
Receipts per ton-mile		0.753 ct.
Revenue per passenger-train-mile		$1.30
Revenue per freight-train-mile		$2.86

Expenses.

Maintenance of way and structures	$368,507,102
Maintenance of equipment	413,199,929
Traffic expenses	55,912,620
Transportation expenses	916,614,826
General expenses	68,485,956
Total operating expenses	$1,822,630,433
Av. Op. Exp. per mile line	$7,691
Av. Op. Exp. per train-mile	$1.49

Capitalization.

Common stock	$6,710,165,538
Preferred stock	1,403,488,842
Funded debt	10,303,474,858
Outstanding capitalization (par)	$18,417,132,238
Outstanding capitalization (in hands of public)	14,338,575,940

Income, Profit and Loss.

Operating roads.		
Net rail operating Rev.	$928,037,002	
Net outside op'r't'g Rev.	2,225,455	
Total Net Rev.		$930,262,457
Taxes accrued		98,034,593
Operating income		$832,227,864
Other income		252,219,946
Gross corporate income		$1,084,447,810
Deduction from gross corporate inc.		567,853,088
Net corporate income		$516,594,722
Dividends from current income	$283,411,828	
Additions, betterments, extensions	55,061,675	
Other reserves	2,640,893	
Disposition of net inc.		$341,114,396
Bal. to credit, profit and loss		$175,480,326
Bal. credit, profit and loss 6/30/'10.		$980,955,458
Leased roads.		
Total lease revenue		$130,496,239
Salaries & maintenance organizat'ns		332,716
Taxes accrued		5,760,634
Income from lease		$124,402,889
Other income		4,258,231
Gross Corp. Inc.		$128,661,120
Deductions from gross Corp. Inc.		62,064,718
Net Corp. Inc.		$66,596,402
Dividends from current income	$35,788,530	
Additions, betterments, extensions	2,700,190	
Other reserves	92,029	
Dispositions of net inc.		$38,580,749
Bal. to credit profit and loss		$28,015,653
Bal. credit profit and loss, 6/30/'10.		$71,528,321

A Convertible Dipper and Hydraulic Dredge has been in use for some time on contract No. 30 of the New York State Barge Canal in dredging the channel in the Mohawk River, between Little Falls and Lock No. 18. At this part, the river bed is solid rock covered with a layer of soft dirt. A 2½-yd. dipper dredge was used at first for removing the dirt preparatory to blasting out the rock. This dredge had a 40-ft. boom of tapered box-girder construction. The excavated material was dumped from the dipper into a scow alongside the dredge. From the scow it was sucked by a 16-in. centrifugal pump installed on the dredge and was discharged through a pipe line to the shore.

Later on it was considered desirable to use an hydraulic dredge. An hydraulic-dredge ladder with suction pipe and 8-bladed cutter was procured and mounted in place of the dipper boom. Since the dredge was already provided with a centrifugal pump, it was only necessary to procure in addition an engine for driving the cutter. The support for the cutter drive and the ball joint between the suction pipe on the ladder frame and that on the hull were so arranged that they could be easily attached and disconnected, making it possible to remove the boom and dipper and substitute the cutter, or vice versa, as the dredging conditions required. The dredge can be completely converted from one type to the other in about two days.

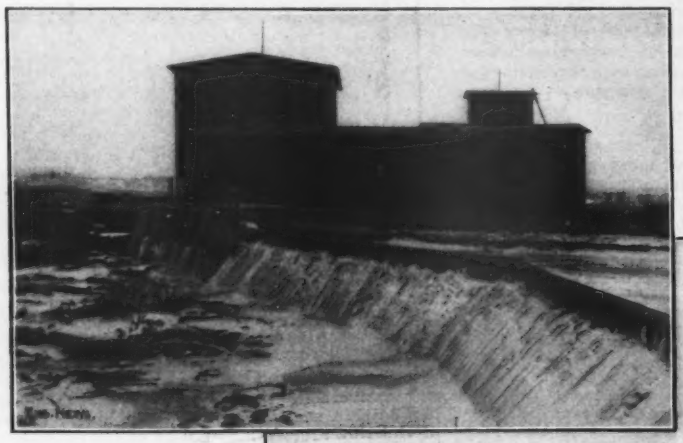
This dredge was designed and built for the Acme Engineering & Contracting Co., by the American Locomotive Co., to whom we are indebted for the above information.

Arizona's Irrigation Statistics.—The Bureau of the Census has issued the following statistics regarding the extent of irrigation in the territory of Arizona. The total area under irrigation in 1909 was 320,051 acres, an increase of 62.2% over that in 1899. In 1910 the total irrigated area was 387,655 acres, with various projects under way to bring the total to 944,090 acres within a few years. In 1909 there were 402 reservoirs, having a capacity of 1,348,358 acre-feet, with 1,608 miles of main ditches for distributing the water. Of the total acreage in 1909, 138,364 acres or 43.2% were irrigated from works built by the U. S. Reclamation Service; 19,386 or 6.1% were irrigated under the U. S. Indian Service acts; by co-operative enterprises, 101,025 acres, or 31.6%; by enterprises supplying water for hire only 80 acres, or 0.1%; by private and partnership enterprises, 61,196 acres, or 19.1%. Streams supplied water for 307,778 acres, or 96.1%; lakes 570 acres, or 0.2%; wells 7,585 acres, or 2.4%; springs 3,631 acres, or 1.1%, and other reservoirs 487 acres, or 0.2%. The total cost of irrigation systems up to July 1, 1910, was $17,651,143. The average cost of irrigation systems per acre of land irrigated was $45.53. The annual cost of maintenance and operation per acre in 1909 was $0.91.

Speed Regulation in the Electric Power Plants of Sioux Falls, S. D.

By H. B. McDERMID.*

Sioux Falls, South Dakota, is situated on the Big Sioux River, in the southeastern corner of the state and, though having only 14,000 inhabitants, is the largest city. It is reached by six railroads, and thus becomes an important distributing center, supplying a large area of country and numerous smaller towns with Eastern manufactured products. This city is apparently much more progressive than most cities of the same size; at night the main streets are brilliantly lighted by the many electric display signs, and give the impression of a larger city. The power plants supplying the current for the city, are of interest because of (1) the very good regulation secured while operating under a violently fluctuating load, (2) the provisions made to take care of all conditions of a widely varying river flow, and (3) the modern design of the later steam equipment installation which has replaced an interesting, but antiquated, outfit.



FIGS. 1, 2 AND 3. DAM AND FOREBAY OF SIOUX FALLS DEVELOPMENT.

The excessive load changes are due to the operation of a comparatively small number of street cars and a number of passenger elevators in the hotels and department stores run by inexperienced operators, and also to the hoisting machinery used in the red-granite quarries of the town.

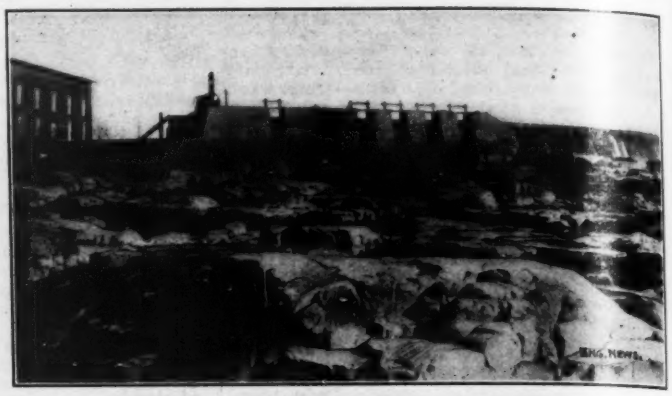
The use of the Big Sioux River imposes conditions difficult to meet because of occasional extremely high flood water, necessitating a special power-house design, and because of periods of very low water requiring a steam stand-by to carry the load in case of the failure of stream flow. Three power plants supply the electrical energy for the various enterprises using that form of power; one, owned by the Bennett Light and Power Co., containing both steam and hydraulic prime movers; and two, owned by the Sioux Falls Light and Power Co. It is the writer's purpose to describe some features of the two latter plants. One of these is a hydraulic development of 2,250 HP. at normal load and under a normal head of 60 ft.; the second is an auxiliary steam plant capable of delivering 1,100 HP. with a new steam-turbine unit.

HYDRAULIC DEVELOPMENT.—The hydraulic plant is favorably situated about one mile from the center of the business district, so that transmission at generator voltages is practicable. The apparatus is housed in a building of red granite and concrete, sufficient granite having been quarried in excavating for the basement of the power house, standing as it does in the middle of extensive ledges of rock, to furnish ample material for the superstructure. This stone has an unusually close-grained texture and fine color and has given the building a finer appearance than usually found.

The dam, shown in Figs. 1, 2 and 3, is of course on a bed rock foundation. It has an approximate length at the crest, of 600 ft. and is surmounted by flashboards, which are capable of raising the head 3 ft. Th's very materially increases the storage capacity of the pond which, at low water, has an area of about 16 acres and, at maximum high water, of 21 acres. There are approximately 2,000 ft. of retaining wall on each side of the river, that on the east side being built of granite masonry while the west wall is of concrete.

Another pond, flooding some 65 acres, is formed by a dam further up the river and gives, with the first, an ample storage capacity for carrying all peak loads when the river is at its normal flow of 1,000 cu. ft. per sec. At present, however, the severe and long continued drought of last summer and fall combined with the very low temperature of the winter season, has decreased the flow until it is possible to use the hydraulic plant only about 25% of the day. It is used at the time when the evening peak load comes on and the steam plant alone is unable to carry all the load. This condition is, however, very unusual and, it is expected, will be eliminated in the near future by a resumption of the natural flow of the river.

The forebay, shown in Figs. 2 and 3, is designed to prevent interruption from ice by reducing the velocity of the intake water. The scheme has proved highly successful in operation. An additional safe-guard against trouble with ice has been secured by the use of a submerged arch under which all intake water must pass, thus effectively preventing the entry of ice into the penstock. Passing through the headgates, the water is delivered to the power house by 700 ft. of 7-ft. steel penstock, seen in Figs. 3 and 4, and having at its lower end a surge tank, 62 ft. high and 16 ft. in diameter, which takes care of sudden pressure changes, in case of severe fluctuations of load. Flange-diaphragm expansion joints are placed in the pipe line to take up the temperature variations in length, found to be several inches.



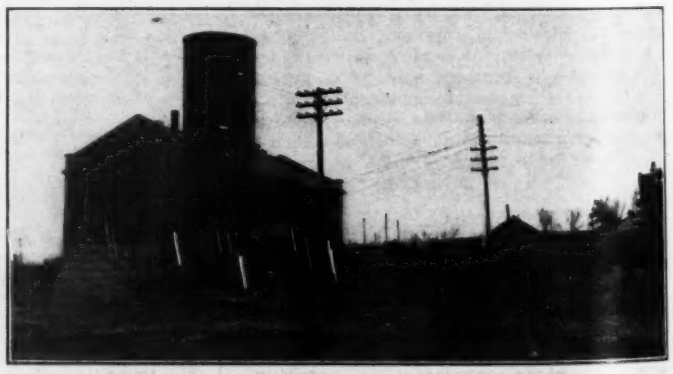


FIG. 4. POWER-HOUSE, SURGE TANK AND PENSTOCK OF THE SIOUX FALLS LIGHT & POWER CO.

On entering the power house the water is distributed by a 10-ft. header from which 54-in. feeder pipes lead to each of 3 850-MP., 300-r.p.m. single, vertical turbines in plate-steel, spiral casings. This type was adopted as a part of the means to care for very high flood water which occasionally prevails, and also on account of the high efficiency obtained with spiral casings under moderate heads.

These turbines, one of which is shown in Fig 5, are each direct-connected to a 500-KW., 60-cycle, three phase, 2,300-volts, alternator of the mushroom type. All revolving parts, including the rotor and flywheel, are entirely supported by a water-cooled thrust bearing running in an oil bath, a support which has proved to be satisfactory and economical in every way.

The generators are excited by a 100-HP. turbine-driven, unit of the same general type as the main units. It can deliver direct current at 125 volts with a normal rating of 400 amps., sufficient for the three units now installed and a fourth, for which space has been provided. In case of accident to this single exciter, its work can be done by a spare motor-generator set, taking current at 2,300 volts from the main busbars and delivering current with the same characteristics as the turbine-driven set. It has, of course, the disadvantage of varying in speed with the main generators in cases of heavy fluctuations of load, while the turbine-driven unit, being independent, is able to maintain a much more uniform speed and excitation current.

The turbines are all regulated by oil-pressure governors of an unusually effective type, as is evidenced by a momentary variation in speed of only 8% when full load is suddenly thrown off, as in case of a circuit breaker going out. The very rapid and severe fluctuations of the commercial load have rendered close regulation very valuable, as well as difficult to obtain, but the problem has been solved by giving close attention to the design of mechanical details and to the layout of the governor system.

*Erecting Engineer, Allis-Chalmers Co., West Allis, Wis.

The arrangement of th's system is worthy of attention, because of its efficient operation and freedom from interruption under any condition of service except the grossest neglect. Fig. 6 shows the layout of the piping system and is largely self explanatory. Its flexibility allows of the running of any combination of governors and pumps. Each of the main units has its own oil pump complete and all are connected, as shown, to a common pressure header so that any one or more of the oil pumps may be run in connection with any one or more governors, there being a connection made to the exciter governor not shown in sketch. The oil used is a medium weight of first-class, engine-lubrication stock and has proved itself well adapted to its work as it keeps the pumps well lubricated and does not readily break down chemically.

The working elements of the pumps consist of two gears, running together inside a casing which fits them on all sides with the smallest possible working clearance. The action is similar to that of a common cycloidal pump, there being no valves or other small working parts to get out of order. The discharge pipes lead through check valves to the pressure tanks, each of wh'ch is capable of holding two barrels of oil at any pressure up to 250 lbs. per sq. in. The pumps are of a constant-capacity type and operate continuously; therefore, each tank is fitted with a relief valve, which can be set at any predetermined pressure and automatically discharges any oil not used by the governor into the storage tank, thus maintaining at all times a uniform supply of oil under proper working pressure. An interconnecting pipe above the oil line provides, with the pressure header mentioned, a means of maintaining the oil in all three tanks at a uniform level when operating them in parallel, with any or all of the pumps running or standing idle.

From the relief valves, and also from the governor exhausts, the escaping oil is conveyed by a common header to a storage tank on the thrust-bearing floor, 8 ft. below the generator floor on which the pumps are located. At the tank, it is passed through a screen which removes any dirt which may have accidentally entered the system, and it also removes any entrained air from the oil. Here also, are the water-cooling coils. Three independent suction lines are taken off from this tank, one to each pump, their intakes being separated as far as possible to insure an adequate supply of oil to each pump under all conditions.

There is a constant volume of oil being pumped at all times; it is diverted at the pressure tanks through either the relief valves or the governors, as the momentary needs may require and then returned again, from either path, to the open storage tank, where it is freed from air, dirt and heat. Thus there is a cool, clean, and air-free oil supply of ample capacity, so essential to the successful operation of any oil-pressure, hydraulic-governing system.

It was found that, with the suction pipes drained and full of air, sufficient vacuum was produced by the pumps, to draw up the o'l almost instantly. The only requirement is that the gears of the pump shall be well wet with oil before starting. A priming pipe from the pressure tank to the suction is provided for this purpose, but is seldom used because the suction pipe is rarely drained in practice and has at its lower end a foot valve which normally keeps it filled with oil. A pet cock on the suction lines furnishes air for the air cushion in the pressure tanks whenever it is necessary to replenish it.

Simple tests of this system have showed it to be well designed for uninterrupted service. With all outlets closed, pressure was raised on one tank from atmospheric to 150 lbs. gage in one minute from the starting of the motor drive. By opening three valves, the system is thrown together in parallel and as a part of the test, the complete system was pumped up to 150 lbs. pressure when thus arranged. The pumps were then shut down, and one of the main generators was started up and kept at normal speed, under no load, by its governor. After nine minutes running, the gages of the oil system showed 65 lbs. pressure. A similar test with only the exciter unit thrown on, showed the oil system capable of keeping it in operation for 20 minutes under like conditions and with a similar drop in pressure. This test showed that sufficient oil capacity was provided to enable any live operator to easily start up another oil pump, should one fail, without the slightest interruption to the general service of the plant, a most desirable condition.

The station is supplied with three motor-generator sets, aggregating some 350 KW. at normal rating, which supply direct current to the street cars and elevator motors about town. These machines take current from the main generators at 2,300 volts, and deliver direct current at 550 volts for the above mentioned service.

The usual switchboard apparatus together wit a Terrill regulator, constant-current transformers for arc lighting, lightning arrestors, etc., is installed to complete the plant. The building is heated by a small steam boiler and lighted by a combination of arc and incandescant lamps. It is served by a hand crane of sufficient capacity to easily handle any load found in dismantling any unit for repairs or alterations.

STEAM AUXILIARY PLANT.—The steam plant of the company is situated on the bank of the river near the heart of the business district and is the original plant of the steam-hydraulic combination. It contains two Heine water-tube boilers each of approximately 400 HP. capacity, generating steam at 135 lbs. pressure. This formerly served two 20 × 42-in. Corliss steam engines which are belted to a jack shaft, from which in turn are belted the generators. These two engines were originally built for 85 lbs. steam pressure and are now operating on a steam pressure 60% higher than that and also running at considerably higher speed than that for which they were designed. The fact that they have given satisfaction under such changed conditions is abundant proof that their design and workmanship was of first-class quality.

When the load became so heavy that these engines could not carry it, an 800-KW., 3,600 r. p. m., steam turbine unit was installed, together with a barometric condenser and the customary exciter sets. The erection of this machine has recently been completed. The old equipment of reciprocating engines, belts, jack shafts, pulleys, etc., occupied a floor space 40 × 80 ft., capable of generating but 600-KW. when forced, looks antiquated, indeed when compared with the new generator room, with its 20 × 27 ft. of floor space, housing a high-speed machine capable of delivering 1,000 KW. Even with this increase in output the steam consumption is only slightly more than that required by the old equipment.

The regulation of the combined system has also been improved by the introduction of the steam turbine unit as it has been found that, whether running alone, or in parallel with the hydraulic plant the voltage variations are so slight as to be imperceptible. When the engines were in service it was possible to count the revolutions per minute by watching the flicker of any incandescent light on the circuit. In justice to the old engines it should be said, however, that they were built many years ago, when the use of electrical power was in its infancy, and the need of extremely accurate regulation and uniform angular velocity was not as generally felt as at present.

The prime movers in both of these plants as well as those in the Bennett company's plant, including hydraulic turbines, generators, auxiliaries, governors and oil pumps, four Corliss engines, and a complete steam turbine set, were built and installed by Allis-Chalmers Co. The belt-driven generators that are used with the old Corliss engines are of General Electric make and were part of the original equipment.

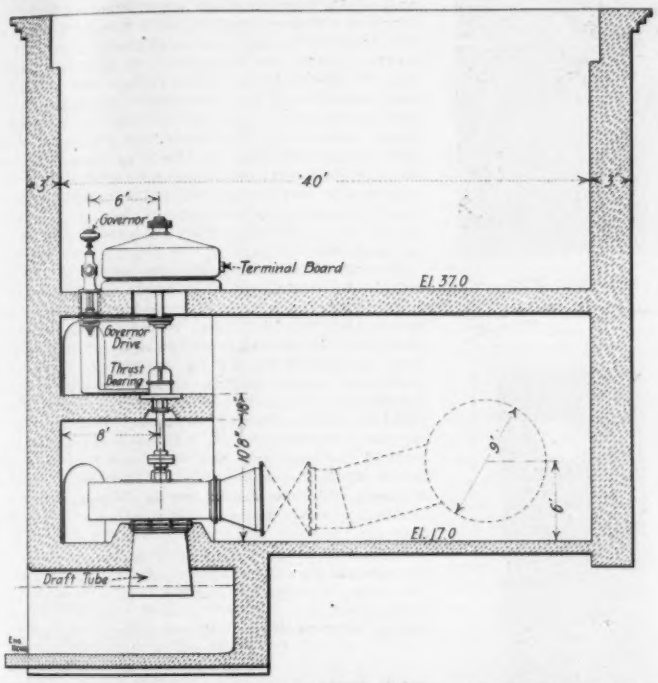


FIG. 5. SECTION THROUGH A GENERATING UNIT, SIOUX FALLS DEVELOPMENT.

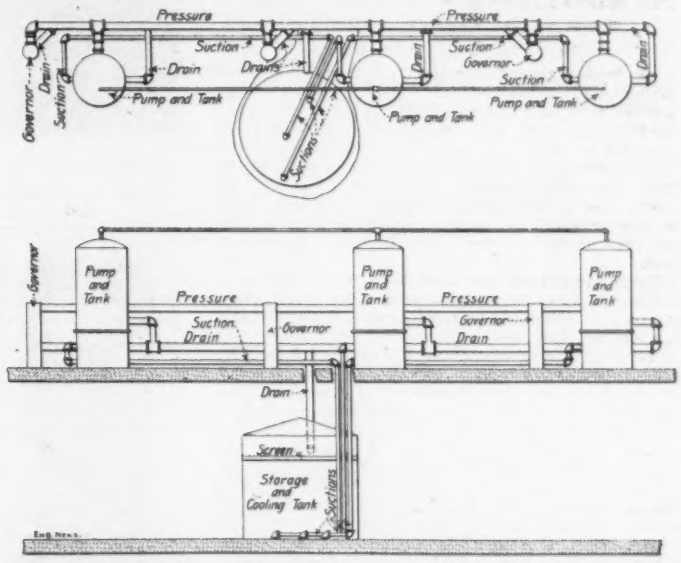


FIG. 6. OIL-PRESSURE SYSTEM FOR HYDRAULIC GOVERNORS; SIOUX FALLS PLANT.

Some Comparative Corrosion Tests of Steels and Irons.

The subject of corrosion of steel received very interested consideration at the recent meeting of the American Society of Testing Materials, as reported briefly in our issues of July 6 and 13, 1911. Three papers describing comparative corrosion tests gave figures which bring out important characteristics of corrosion tests, and we therefore reproduce the substance of these papers herewith. The most prominent characteristic is the great variability of results under seemingly identical conditions (as in the figures given by Mr. A. W. Carpenter), and the influence of very small variations in test method or composition of metal (tests of Mr. C. M. Chapman and Prof. W. H. Walker).

The unavoidable factors of variation in metals and corrosion as well as in tests of corrosion resistance are so great that it is doubtful whether greater clearness of knowledge will be attained within measurable time. Yet the extreme importance of the subject justifies strong effort to reach better knowledge. The development of uniform, reproducible test methods having positive and invariable relation to what might be called "commercial rusting" is the first essential; the papers given below are directly concerned with this problem.

The Marked Influence of Copper in Iron and Steel on the Acid Corrosion Test.

By WILLIAM H. WALKER.*

In investigating samples of iron and steel which had withstood corrosion for years and which notwithstanding dissolved in acid very readily, together with samples which withstood solution in acid in a remarkable manner and yet were rusting at the ordinary rate, it was found that the acid-resistant specimens contained in every case a substantial amount of copper; that is, the presence of copper seemed to be the controlling factor in the resistance to solution in acid.

Upon examining the literature of the subject, sufficient data to justify this conclusion were found. A number of investigators have studied the matter, and the results of all are fairly well presented in the Carnegie Research Report of Pierre Breuil on Copper Steels, in the Journal of the Iron and Steel Institute of Great Britain for 1907. It is here found that small amounts of copper in iron or steel reduce enormously the tendency to pass into solution in acid.

In order to determine whether there is any foundation for the alleged fact so widely disseminated, that a highly acid-resisting iron or steel is also therefore a very pure product, the writer succeeded in having made a number of heats in a basic open-hearth steel furnace, under ordinary conditions, and using ordinary materials, into which metallic copper was added a little before or during tapping. The treatment of the product in the bar and sheet mills, and the annealing operation, were in every case as nearly identical as could be maintained. Although, as the work developed, many heats were made, the results were so uniform that but few will be here presented.

COMPOSITION AND ACID-LOSS OF OPEN HEARTH STEELS CONTAINING COPPER.

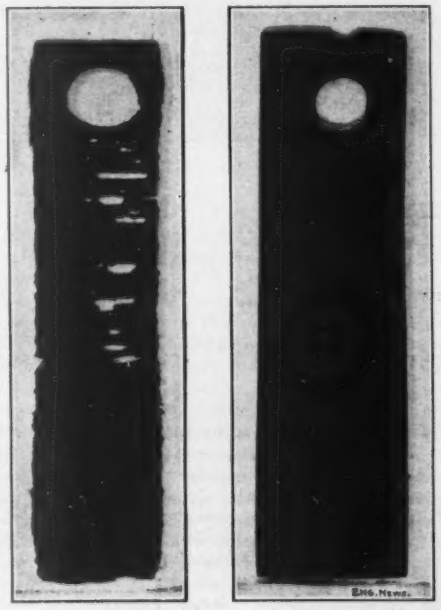
	A.	A_2	B.	C.
Carbon, per cent.....	.08	.08	.10	.09
Manganese, per cent. .	.50	.50	.41	.31
Sulphur, per cent.....	.018	.018	.027	.031
Phosphorus, per cent...	.017	.017	.026	.063
Copper, per cent.....	....	.21	.19	.19
Loss in weight in 20% sulphuric acid in 3 hrs., grams	.2235	.0075	.0082	.0095

The influence of small amounts of copper in these heats is truly remarkable and shows conclusively that this wonderfully slight tendency to dissolve in acid is not indicative of great purity.

Inasmuch as the presence of metallic copper in contact with iron increases enormously the rapidity with which such iron will dissolve in acid, it at first seems surprising that in this case copper should retard this action. But we have a direct analogy in the case of zinc and copper. Zinc free from iron dissolves in acid very slowly; mix with it some metallic copper, however, and solution is greatly accelerated. But make an alloy of the two, namely brass, and the solvent action of the acid is negligible. So long as copper is not added to iron or steel in excess of the amount which can remain homogeneously alloyed therewith, the writer can see no reason why there may not be an advantage in its use. But such advantage cannot be ascribed to purity, but rather to what we may call a ferro-brass of small copper content. Reasoning from analogy with zinc, pure iron should dissolve in acid very slowly; but the converse is here shown not to be true, namely, that a slow-

Common Steel. Improved Iron.

Fig. 1. Weather Exposure for 18 Months.



Common Steel. Improved Iron.

Fig. 2. Acid Test for 12 Hours.

(Comparative Effects of Weather Corrosion and Acid Corrosion on Common Steel and on "Improved Iron.")

dissolving iron or steel is on this account to be considered an exceptionally pure product.

The Value of the Sulphuric Acid Corrosion Test.

By CLOYD M. CHAPMAN.*

[Abstract]

Users of sheet iron and steel have been persuaded to believe that a metal which will best stand the sulphuric acid test as outlined in the Proceedings of the American Society for Testing Materials, Vol. VII, 1907, p. 231, is the one which will last longest under the usual conditions of weather exposure. This sulphuric acid test may be briefly described as follows: Samples of the metals to be tested are prepared by polishing their surfaces with fine emery, rubbing in a direction at right angles to the direction in which the metal was rolled. The size of the test piece recommended is 1/16 × ½ × 2 ins. After careful weighing, these small plates are immersed in a 20% solution of chemically pure sulphuric acid for one hour at a temperature of 15° C. They are then removed from the acid, washed, dried, and again weighed. The loss in weight is taken as an indication of the ability of the metal to withstand corrosive influences.

To demonstrate the differences between the weather exposure test and the sulphuric acid test, there are shown in Fig. 1 photographs of two plates, one of improved iron and one of common steel, showing results of weather exposure for 18 months. The improved iron contained only minute quantities of impurities; the steel analyzed about 0.06% carbon, 0.095% phosphorus, and 0.38% manganese. These plates were clean and new when exposed side by side on the roof of the Maritime Building at the southern extremity of Manhattan. They seemed to be rather free from mill scale, but any mill scale present was left on, as it usually would be in practice. They were exposed at an angle of 45° facing south. This exposure is a rather severe one because of the fogs, smoke, and the salt air from the bay, all of which are present in this locality. At the end of 18 months they were removed and their surfaces briskly brushed with a wire brush until the rust was removed and the surface of the metal brought to a polish. A careful examination of these plates fails to show any considerable difference in the corrosion and pitting which has taken place. As far as the eye can distinguish, each plate has rusted to the same extent. The depth and size of the pits formed by rust on the surfaces of these two plates are very nearly the same, but careful comparison shows slightly larger and deeper marks on the surface of the improved iron than on the surface of the common steel [Fig. 1.].

Having thus compared the ability of the two metals to withstand the action of the weather, a sulphuric acid test was made on parts of the same plates which had been exposed to the weather. Strips cut from the ends of these plates were prepared as above described, brought to about the same weight, and immersed in dilute sulphuric acid until one of them was nearly destroyed, while the other had lost only 7% in weight. At the end of the one-hour period prescribed by the test, the improved iron had lost .083% while the common steel had lost 6.7%. Fig. 2 shows the two specimens as they appeared after being subjected to the acid test for twelve hours.

It is quite unnecessary to point out that although weather exposure caused approximately the same amount of rusting and pitting on the two plates, yet under the acid test one was attacked several times as violently as the other.

Some Tests of the Rate of Corrosion of Metals Exposed in a Gaseous Atmosphere.

By A. W. CARPENTER.*

[Abstract]

The problem of finding a suitable metal for structural purposes, not prohibitive in cost, which will resist corrosion when exposed to locomotive gases, is important to railroads. In order to get first-hand information, the N. Y. C. & H. R. R. R. Co.'s Engineering Department (Mr. Geo. W. Kittredge, Chief Engineer) has made some tests which, while perhaps crude and limited, still are thought to give some valuable information both on the rate of corrosion of the metals tested and on the comparative rate of corrosion of iron and steel.

Pieces of the metals to be tested, generally in the form of thin sheets, were exposed in two places, one in a tunnel where the atmosphere is very highly charged with locomotive gases and steam, the other the interior of a smoke-jack in an engine-house. In the tunnel exposure the specimens were attached to a wooden frame fastened to one side of the tunnel, in which location they received no blast action from locomotives and it was thought that all would be exposed to equal conditions. In the smoke-jack the plates were hung inside the jack so that the conditions would probably be equal for all plates.

In the first test-series, only few results were obtained. A plate of special iron exposed in the smoke-jack for 189 days corroded at the rate of about 1/32-in. per annum for each surface, or 1/16-in. per annum for a plate with both sides exposed.

In the second series of tests the tunnel test

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showed resistances to corrosion in the following order, beginning with the most resistant, and with a loss after 289 days total exposure as given:

SECOND SERIES, TUNNEL TEST.

	Loss, grams per sq. in. surface.
Special-coated metal	0.51
Soft steel, uncoated	0.55
Special galvanized iron	0.67
Special iron, uncoated	1.72

The excessive corrosion of the special uncoated iron over that of the others will be noted. The amount of this corrosion, compared with that of the similar material in the smoke-jack tests, shows the tunnel conditions to be very much less severe than those of the smoke-jack.

In the smoke-jack one of the special-coated plates, one special iron galvanized plate and one special iron plain plate were exposed. At the first examination, after 65 days exposure, the special-coated metal showed very much less corrosion than the special iron plates, but this plate was lost before the second examination took place, leaving only the special iron plates, one plain and one galvanized, in this test. The galvanizing was pretty well removed during the first period of exposure (65 days) and thereafter did not assist much (although it did a little). The last examination, after a total exposure of 193 days, showed a loss about the same as that in the first series (189 days' total exposure).

A third and more extensive series of tests has been inaugurated this year and one examination of one exposure (in tunnel, 58 days) has been made. This series includes special irons, ordinary wrought-iron, various steels, and some special non-ferric metal. Some of the irons and steels have galvanized coatings and some have lead coatings over the galvanizing.

Some of the results of the one examination so far recorded for this series were unexpected. The galvanized plates show the greatest loss of the ferric metals. The loss of one lead-coated plate was some 75% greater than that of the other, which might be accounted for by the difference in thickness of the respective lead coatings as indicated by the chemical analyses of the two plates, but as one of these analyses was made upon sheared samples and the other upon drillings the writer does not wish to put too much weight upon this point. The average loss of the two lead-coated plates was greater than that of one of the special plain irons and the open-hearth steel angles. The special "A" iron was accepted as the same material as the special iron of previous tests; in this examination it reversed its previous record, being the most resistant, for the short period exposed.

The relative order of resistance of the specimens for the 58 days' exposure was as follows, beginning with the most resistant:

	Average loss, grams per sq. in.
1. Special "A" iron sheets, plain	.047
2. Open-hearth steel angles, plain	.060
3. Lead-coated, galvanized steel sheets.	.067
4. Special "B" iron sheets, plain	.077
5. Open-hearth steel bars, plain	.082
6. Wrought-iron sheets, plain	.090
7. Open-hearth soft steel plates, plain	.095
8. Bessemer steel angles, plain	.098
9. Special "A" iron sheets, galvanized	.131
10. Special "B" iron sheets, galvanized	.137
11. Bessemer steel bars, plain	.147
12. Special non-ferric metal sheet, plain.	.226

The calculated rate per annum from the above, assuming a uniform rate of corrosion, would be 0.002-in. to 0.011-in. per sq. in. of each surface.

It should be borne in mind that the time of exposure for this series was too short to lead to proper conclusions from the results. The specimens in the smoke-jack exposure will be removed and examined after having remained about the same number of days as those which were in the tunnel, and both sets will be returned to their respective exposures and the tests continued, it being the intention to make examinations after successive exposures of about 60 days.

A Large Steel Ingot.—An ingot weighing 130 tons, probably the largest ever produced in the United Kingdom, has been cast by Messrs. Cammell, Laird & Co. at their Grimesthorpe Works, Sheffield. It was over 15 ft. long; at one end it measured 9 ft. × 4 ft. 9 ins., and at the other it was 9 ft. 3 ins. × 5 ft. The ingot was slabbed down to about 2 ft. 6 ins. thick, which process reduced the weight to about 90 tons, and it was then rolled into a mild steel plate. The rolling operation was carried out in the armor-plate mill, which is believed to be the largest and most powerful in the world and is driven by engines of 12,000 HP. When the operation was completed the plate was 18 ft. 6 ins. long, 10 ft. 9 ins. broad, and 25 ins. thick.—London "Times," July 12.

Ferrite Cements and Ferro-Portlands

By EDWIN C. ECKEL, Assoc. Am. Soc. C. E.*

It seems desirable to preface this paper on the high-iron cements with a brief explanation, in order to forestall one possible line of adverse criticism. The explanation refers merely to the writer's personal relation to the subject. Concerning this, it is necessary to say that he is a co-inventor of one of the iron-cement processes, and that he is directly interested in seeing that cements of the type here discussed are developed into commercial products. On the other hand, the paper would have been written, regardless of this personal interest, and it is believed that it can be accepted as an unbiased statement of the present status of the high-iron cements. Fortunately, the subject is one in which the statements can be readily checked by experiment, and the writer will be glad to cooperate with any laboratory or engineer desirous of applying such checks.

DEFINITIONS AND NOMENCLATURE.

The cementing materials to be considered in the present paper agree among themselves and differ from normal Portland cements in that they contain relatively high percentages of iron oxide, as compared to alumina, while in the normal Portlands these relations of the iron oxide and alumina are reversed.

In normal Portland cements the ratio of alumina to iron oxide usually falls between the limits of 2:1 and 3:1, though occasionally it is as high as 4:1, or, more rarely, as low as 1½:1. The fact that the ratio is relatively constant, and always in the same direction, is due to the fact that in normal Portlands the acid elements of the cement are derived either from a natural argillaceous raw material, such as clay, shale or cement-rock or from an artificial raw material like slag; and in all of these materials the alumina is largely in excess of the iron oxide. Since this relation of alumina to iron cannot be changed by raising or lowering the percentage of limestone in the mix the finished cements must, of course, show the same relation, usually accentuated somewhat owing to additional alumina picked up from the coal ash and the kiln lining.

In the white Portland cements, whose absence of color is due to the practical absence of iron oxide from the raw materials the alumina-iron ratio is, of course, still higher than in normal Portlands, and may theoretically approach infinity.

The preceding statements will serve to show how sharply distinguished from the commercial products of the present day are the high-iron cements, which for convenience are here separated into two classes. The following tabular scheme will do away with the necessity for lengthy definition.

CLASSIFICATION OF PORTLAND CEMENTS AND ALLIED PRODUCTS.

A. HIGH ALUMINA CEMENTS; containing more alumina than iron oxide.

A. 1. WHITE PORTLAND CEMENTS: containing practically no iron oxide, their alumina-iron oxide ratio ranging from 6:1 to near infinity.

A. 2. NORMAL or ALUMINA-PORTLAND CEMENTS; containing appreciable percentages of iron oxide, their alumina-iron oxide ratio ranging from 1:1 to 6:1, though usually falling between 2:1 and 3:1.

B. HIGH-IRON CEMENTS; containing more iron oxide than alumina.

B. 1. FERRO-PORTLANDS ; containing appreciable percentages of alumina, their iron-oxide-alumina ratio ranging between 1:1 and 4:1.

B. 2. FERRITE CEMENTS; containing little or no alumina, their iron oxide-alumina ratio ranging above 4:1.

The cements of the four classes above distinguished differ not only in their chemical composition, but in their physical properties. In the opinion of the writer, there are to-day good reasons for manufacturing cements of each of these four types. Their fields of use will be quite distinct, and it will be a serious error if an attempt is made to frame one set of specifications to cover all four of these products.

LEGAL STATUS OF THE HIGH-IRON CEMENTS.—In these days, when patents in certain lines seem to be of more use in making prices than in manufacturing products, it is probably best to discuss briefly the legal side of the iron-cement situation.

The idea of making high-iron cements is traceable so far back in patent office history that at the present day no broad basal patents can be secured. Each of the two processes which now seem to be commercially promising is therefore limited, so far as its patent rights are concerned. The Michaelis patent, for example, is expressly restricted to ferrite cements, "practically free from alumina," and, further, to the use of iron ore as a raw material in such manufacture. The Spencer-Eckel patents, on the other hand, relate to the manufacture of high-iron cements, with the coincident recovery of potash from a potash-rich mix. It is obvious that, theoretically, there are many ways in which all of these existing patents could be avoided. The commercial side of the matter is, however, quite another story.

CONDITIONS OF MANUFACTURE.

AVAILABLE IRON-BEARING MATERIALS.—The element iron, in one combination or another, is a common and almost invariable constituent of the minerals and rocks which make up the crust of the earth. At first sight, therefore, it might seem as if an almost limitless number of natural raw materials were available for use in the manufacture of high-iron cements. This would, indeed, be the case if it were not for the fact that the raw material, to be suitable for this use, must not only be rich in iron, but must also be very low in both alumina and magnesia. These restrictions bar out many common iron-bearing rocks which would be otherwise available, for in most of the basic igneous rocks high iron is accompanied by high magnesia. They also bar out most of the cheaper low-grade iron-ores, for these low-grade ores are in most cases relatively high in alumina. All of the immense iron-ore beds of the north coast of Cuba, for example, are so high in alumina as to be useless for the purpose under consideration.

When, in addition to the preceding chemical requirements, commercial factors are taken into consideration, it becomes evident that the only available natural raw materials are (1) high-grade iron ores—almost pure ferric oxides; (2) iron ores of lower grade, but practically free from alumina and magnesia—which are ores of a very uncommon type, and (3) a few natural ferrous silicates—of which glauconite or greensand is the only commercially suitable example.

In considering the commercial side of this question, it is obvious that for some time to come the Atlantic coast will be the most important market for a cement of the type under discussion; and, further, that on this coast the largest demand will be in the area between Norfolk and Boston. The question of raw-material supply may, therefore, be examined with this limitation on its scope.

So far as available iron ores within this zone are concerned, the supply is conveniently grouped as follows:

1. Magnetites from the Hudson Highlands, from New Jersey or Pennsylvania.
2. Brown ores from the north coast of Cuba.
3. Hematites from the Santiago region of Cuba.
4. Hematites from Newfoundland.
5. Hematites from Spain.
6. Magnetites from Sweden, Norway, etc.

These ores range from 45% to over 60% in metallic iron, the lower being shown by the Cuban brown ores. At points along the Atlantic coast, ores of any of the types noted are worth from $3.00 to $3.50 per ton, in normal years, for blast-furnace use.

The principal other iron-bearing material available is greensand. This occurs in heavy deposits in New Jersey and other coastal States, and can be stripped, quarried and placed on cars for from 15 to 30 cts. per ton. It carries about 50% silica,

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30% ferrous oxide, 8% potash and 3 to 8% alumina. Actually, it is a double silicate of potash and iron, the iron being in the ferrous form, except after long weathering. Since the silica is already combined with the iron oxide, both readily unite with the lime of a cement mixture at the ordinary temperature of the rotary kiln.

DIFFICULTIES IN PROPORTIONING THE MIX.—Certain difficulties are encountered when an attempt is made to produce at reasonable cost a high-iron cement of good technical properties. These same difficulties are met with, whether iron ore or greensand be used in the mix, though they are more serious in one case than in the other. They arise from the low combining value of iron; they must inevitably be reckoned with in making a cement of this type, but, fortunately, they are not insurmountable.

The character of the trouble is best illustrated by taking an extreme case. If we mixed a pure limestone and a pure iron ore the result, on burning, would be a pure lime ferrite, which could carry only 41.3% lime to 58.7% iron oxide. Many years ago Newberry prepared this ferrite, and determined that it was not available as a commercial cement. To give it useful properties, it is necessary to raise the percentage of lime, and to introduce silica as a third constituent. When these are done, we have a ferrite cement or a ferro-Portland, according to the amount of alumina we have also incidentally introduced.

The introduction of silica and lime seems simple enough, until the composition of natural raw materials is considered, in view of the additional facts that little or no alumina and magnesia are permissible. The additional lime required can, of course, be secured simply and cheaply by using more limestone, but it is not a simple matter to add silica in combinable form without at the same time bringing in an undesirable quantity of alumina; and probably it is this difficulty which is largely responsible for the current idea that high-iron cements are necessarily expensive to make. Fortunately, this problem was solved by some very early experimental work by the writer, so that it is now feasible to make an iron-cement of any desired silica content. The details of this phase of the subject cannot be discussed now, as the Patent Office is still struggling with the problem, but the technical and commercial success of the process can be accepted as already demonstrated.

MANUFACTURE AND PROPERTIES.—High-iron cements of the Michaelis type, made by the use of iron ore, have now been manufactured for a number of years in Germany. The first ferro-Portlands made from greensand were for experimental purposes only, but more recently cements of the Spencer-Eckel type have been burned in full-size kilns at the plants of the American Cement Company at Egypt, Penn, and of the Norfolk Portland Cement Corporation, of Norfolk, Va. In the course of this work on both types of cement, certain points regarding the manufacture and properties of the high-iron cements have been determined. These facts seem to hold true regardless of whether iron ore or greensand is used.

One point to be noted is that the burning of the iron cements takes place at a materially lower temperature than the burning of the normal Portlands. This is, of course, an advantage, but it is partly compensated for by the fact that in dealing with a cement mixture rich in iron the sintering and fusing points of the mixtures are quite close together. Until the burner becomes accustomed to the mixture he is therefore likely to overburn the clinker, so as to give a very hard and partly or completely fused product. When proper burning has once been established, however, the same kiln will yield an appreciable higher output per day of iron cement than of normal Portland.

The analyses in Table I. of ferro-Portland made by the use of iron ore are fairly representative of the type. It must be said, however, that many of the cements made by the Michaelis process at the Hemmoor plant approximate much more closely to the pure ferrite type than does these analyses, usually carrying only 1 to 2% of alumina.

TABLE 1.—ANALYSES OF FERRO-PORTLAND, MICHAELIS TYPE.

	Per cent.		
Silica	23.44	19.47	20.42
Alumina	2.98	3.47	3.39
Iron oxide	7.48	9.44	6.47
Lime	61.86	63.50	63.48
Magnesia	0.50	0.64	0.30
Sulphur trioxide	1.72	*2.15	*2.01
Ignition loss	0.69	0.78	1.48

*Calcium sulphate.

For comparison with the above analyses, a series of analyses of ferro-Portlands made by the use of greensand are presented in Table II.

TABLE I.—ANALYSES OF FERRO-PORTLAND.

Constituent.	Cement 1.	Cement 2.	Cement 3.	Cement 4.
Silica	20.37	19.52	22.76	22.98
Alumina	3.64	3.30	5.56	5.92
Iron oxide	8.97	7.38	8.50	8.36
Lime	61.42	62.62	56.59	56.92
Magnesia	0.82	4.12	3.39	3.33
Sulphur trioxide.	1.19	0.42	0.59	0.55
Ignition loss	1.07	1.48	1.00	0.40
Cementation index	1.08	0.93	1.23	1.25

All of the analyses of ferro-Portlands given in Table II. show the influence of the low-grade limestone used in making up the mixes. In the case of cement No. 1, the limestone used was a shell-marl, carrying not over 90% lime carbonate, and very high silica and alumina, though low in magnesia. In the cases of cements 2, 3 and 4, the limestone used was a low-limed Lehigh district product, carrying high percentages not only of silica and alumina, but also of magnesia. If purer limestones had been used with the same greensand, the cements would have shown in every case magnesia 0.50% or less, with not over 2% alumina. A series of such cements is now under preparation.

So far as physical properties are concerned, the high-iron cements show certain peculiarities which must always be taken into account. They are, of course, more resistant to the action of seawater and of alkali water than are the normal Portlands. This point need not be further discussed in the present place, since it is one of the principal reasons for the adoption of this type of cement. Entirely aside from the different behavior which they show in salt water, the high-iron cements are always very slow setting, as compared with the normal or aluminous Portlands. They are also slow to harden, unless gypsum or plaster be added. The addition of gypsum is, in the case of the high-iron cement, not made in order to retard the set, as in the case of the normal Portland. It is questionable whether all ferrite cements, as well as ferro-Portlands, will require the addition of gypsum, and this matter is still under consideration.

The short-time tests of iron cement are relatively lower than those for longer periods. The tabulation (Table III.) of the tests on ferro-Portland will serve to give some idea of the physical properties of this group. In Germany very extensive investigations have been undertaken along this line, and full data are available concerning the properties of the Michaelis type of ferro-Portland.

TABLE III.—PHYSICAL TESTS ON FERRO-PORTLANDS; CEMENT NO. 2.

	Fresh water.	Salt water.
Initial set	6 hrs. 5 min.	5 hrs. 30 min.
Final set	9 hrs. 10 min.	9 hrs. 5 min.
Tensile: 24 hours, neat	267 lbs.	368 lbs.
" : 7 days, neat	688 lbs.	881 lbs.
" : 7 days, 1:3 sand	195 lbs.	285 lbs.
" : 28 days, neat	888 lbs.	887 lbs.
" : 28 days, 1:3 sand	322 lbs.	321 lbs.

This cement (S-E. No. 2) was, of course, an over-limed product, as shown by the fact that its cementation index was less than unity. On the other hand cements 3 and 4, which were lower in lime than would be commercially desirable, still gave very fair tensile strength tests. The seven-day tests on these two cements gave, for example, the following results:

	Cement No. 3.	Cement No. 4.
7 days neat	483 lbs.	554 lbs.
7 days; 1:3 sand	177 lbs.	218 lbs.

Tests on cement No. 1, which is normally limed, are now in progress, but no data will be available for publication until the official report on these experiments is issued. At present it can only be said, from information at hand, that the cement is showing up more than favorably as compared with the normal Portlands which are undergoing the same tests.

COST OF MANUFACTURE.—In a number of publications dealing with the manufacture of high-iron cements, it is either stated or implied that the cost of their manufacture is considerably in excess of the cost of manufacture of normal Portland cement. As a matter of fact it is not necessarily the case that it will cost more to manufacture a high-iron cement than a normal Portland, and in many localities the high-iron cement will be actually the cheaper to make. It is, of course, true that if one of the raw materials be very expensive, the resulting cement will necessarily be high in cost as well as in iron. This is the case when a high-grade iron ore is used. Such ores are worth from $3 to $3.50 per ton at Atlantic coast points for blast-furnace use; and of course, the cement manufacturer could not hope to secure them at a lower price for his own business. With regard to greensand, however, the case is very different. There are a number of good cement manufacturing points along the northern and central Atlantic coast where greensand could be quarried by steam shovel and delivered to the cement plant at costs ranging from 15 to 30 cts. per ton.

So far as actual manufacturing goes, the iron-cements would probably show a slightly lower coal consumption per barrel than the normal Portlands and there will also be a slight saving, due to the fact that ordinarily it will not be necessary to use gypsum with the iron-cement. In Table IV. some of these factors are summarized in the shape of a series of estimates of cost per barrel of various cements:

TABLE IV.—TOTAL COSTS OF RAW MATERIALS, PER BARREL.

Raw materials.	Normal Portland.	Ferro-Portland using iron ore.	Ferro-Portland using greensand.
200 lbs. coal at $2.25 per ton	$0.225	$0.225	$0.225
450 lbs. limestone at $0.50 per ton	.1125	.1125	.1125
150 lbs. clay at $0.30 per ton	.0225	.....	.....
150 lbs. ore at $3 per ton	.....	.225	.....
150 lbs. greensand at $0.30 per ton	.....	.....	.0225
10 lbs. gypsum at $3 per ton	.015	.....	.....
Total cost raw materials	$0.375	$0.5625	$0.36

From this comparative table it will be seen that the question of high manufacturing cost need not be a factor in retarding the adoption of high-iron cements, provided their technical properties are sufficiently valuable to render such adoption advisable. The most expensive possible high-iron cement will cost, at Atlantic coast points, only 20 cts. per barrel more than a normal Portland, while the less expensive iron cement will actually be a trifle cheaper to make than the ordinary Portland. It may be added that the figures in the preceding table represent the actual costs of material averaged for three promising cement locations on the middle Atlantic coast, and that at least one of these points the advantage would be still more heavily in favor of the high-iron products. In these comparisons, no allowance has been made for lowering of cost, due to potash recovery when green sand is used.

Notes From Engineering Schools.

COLUMBIA UNIVERSITY.—The Board of Extension Teaching has announced two evening courses in surveying for the coming year. (1) A course in plane surveying, given on Thursday evenings from September to June, will cover the adjustment, care, and use of the common surveying instruments, the principles of city, stadia and construction surveys and the office work connected therewith. (2) A course in railroad surveying, including the theory of curves, turnouts, etc., and the solution of many practical problems will be given on Monday evenings. A knowledge of plane trigonometry will be required for admission to the first course, and a knowledge of practical surveying as well will be essential for admission to the course in railroad surveying. These courses are intended to give an opportunity to young men who are occupied during the day to obtain, at a very moderate cost, the best of instruction in this field. Further particulars may be obtained by addressing the Secretary of Columbia University, New York

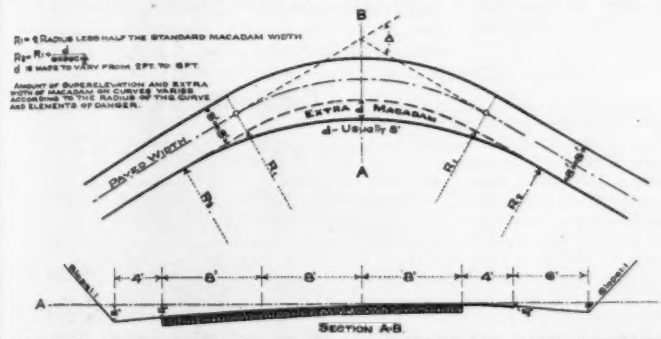
Superelevation for Curves on Macadam Roads.

The use of automobiles traveling at high rates of speed has brought attention to an element in road design and construction which hitherto received little notice. This is the widening of roadbed and superelevation of the outer edge on curves. The dangers to automobiles on curves are twofold; that of skidding into the side ditch, and that of collision with vehicles traveling in the opposite direction. The skidding is disastrous not only to the automobile, but to the wearing coat of the road.

Wherever the country traversed will permit, it is, of course, preferable to avoid sharp curvature; but often this cannot be done in developed localites without heavy expense. At such points every effort should be made to remove trees and shrubbery which will obstruct a clear view from either end of the curve, and the traveled roadbed itself should be widened as much as practicable.

The accompanying illustration shows a typical layout for such a curve, as adopted by the Los Angeles County Highway Commission of California, for a locality which is widely known for the excellence of its roads. The curve for the inside of the roadbed is not concentric with the curve of the bend, but usually has a considerably longer radius than that of the outside, and is so centered as to give the inside curve the effect of a taper, its tangent points extending beyond the tangent points of the outside curve.

The cross-section in the same sketch illustrates the method of superelevating the outer edge. While the amount of superelevation of the outer rail on railway curves has been reduced to a fairly satisfactory standard, depending on the



TYPICAL ROAD LAYOUT AND CROSS-SECTION, LOS ANGELES COUNTY HIGHWAY COMMISSION, MR. A. E. LODER, CHIEF ENGINEER.

speed and degree of curve, the case with interurban highways is much more difficult to deal with. The varying rates of speed and the wide difference in the character of traffic make fixed rules and formulas out of the question. The elements in each case must be arbitrarily determined, dependent upon the importance of the highway, the probable speed and volume of travel, the obstructions to view and the sharpness of the curve. Care must be taken in some cases that the bank on the outside of the curve will not damage abutting property by an unreasonable fill; and that ample drainage can be secured from the lowest edge of the pavement on the inside.

In finishing the pavement, the crown must be thrown well outside of the center of the pavement and slightly flattened. It is a mistake to eliminate the crown altogether. While no fixed rule is being followed, in the Los Angeles County highway work, from a report of which these data are taken, the maximum superelevation on moderate curves has rarely been steeper than 0.8 ft. for a 16-ft. roadway, or at the rate of about 0.05 ft. of superelevation per foot of width of macadam on bad curves. On easy curves this rate is decreased. A practical and easy riding entrance to the curve can best be laid out by the trained eye on the ground.

In one case on an important highway, where the right-of-way makes a sharp angle of 68°, the macadam was laid with a center line radius of 80 ft. Actual tests since the completion of this road demonstrate that a speed of 30 miles per hour can be maintained with safety and comfort in passing this point. The result is due to a properly elevated and tapered curve, although the superelevation is barely noticeable at first glance.

Third-tracking of Elevated Railways on certain lines in New York City was authorized by the Public Service Commission of that city on Aug. 1. The permission is to the Interborough Rapid Transit Co. (which owns the elevated railways of Manhattan and Bronx and operates the existing municipal subway). It covers large parts of the Second Ave. and Third Ave. and some of the Ninth Ave. elevated line as to laying a third track, and permits building certain extensions. The city is to receive half the increase of revenue realized from the new work. This subject has been a matter of contention between the company and the commission for several years, and during that time the company made all its offers for new subway construction contingent upon permits to third-track the elevated railways, to which the commission was opposed unless a short franchise period were stipulated. The present action gives the right to the company independent of any subway action, and was taken on the initiative of the commission without application or acceptance by the company.

Two Serious Butting Collisions involving excursion trains occurred last week. An excursion train on the Seaboard Air Line Ry. collided with a freight at Hamlet, N. C., July 27. The excursion train, bound from Durham to Charlotte, N. C., was made up of eleven coaches with about 900 passengers on board. This train was running at full speed and the freight slowly when they struck. The locomotives were demolished and six of the coaches were crumpled together. Eight passengers were killed and about 60 others were badly injured, some fatally. A collision on the Bangor & Aroostook R. R. at Grindstone, Me., July 28, between an excursion train and a regular passenger train is ascribed to a misunderstanding of train orders. The two trains were to pass at this station but the excursion train was a minute late and the regular passenger pulled out of the station without waiting for it. The locomotives were wrecked and the smoking car of the special, just behind its locomotive, was telescoped. No other car of either train left the rails and all the five passengers killed were in this car. Besides the five passengers, three trainmen were killed, and 16 persons were seriously injured.

The loss of life in both these collisions may probably be ascribed to the use of ancient and flimsy rolling stock in excursion specials.

An Entombed Miner was reached by rescuers Aug. 1 in a mine near Joplin, Mo., after having been imprisoned for 52 hours. The man was caught by an extensive cave-in on July 30, but was uninjured, although his escape from the drift was cut off. Four drill holes were sunk by rescue parties and the fourth penetrated the right drift. The imprisoned man 75 ft. below the surface announced through the hole that he was in good health but was up to his armpits in water. Food was lowered through the hole and the rescuers started sinking a shaft. The drift was reached and the miner taken out unhurt on Aug. 2.

Ammonia Refrigeration Tanks Exploded July 30 during a fire at Brockton, Mass., which destroyed the Satucket Block and part of the Holbrook Bldg. Three firemen were badly injured. The tanks were a part of the cold storage plant of the Brockton Public Market Co.

A Notable Aeroplane Contest was won by Lieut. Conneau, flying under the name of André Beaumont, on July 26. A 1,010-mile course from Brooklands, near London, around the English and Scotch coasts through Harrowgate, Newcastle, Edinburgh, Stirling, Glasgow, Carlisle, Manchester, Bristol, Exeter and Brighton, was covered in 22 hrs. 28 min. flying time. The total elapsed time, however, covered several days. Pierre Vedrine finished a close second with a record of 22 hrs. 58 min. 55 sec.

An English aviator, Germal Napier, was killed on Aug. 1, while flying with a passenger at Brooklands, near London. The aeroplane was capsized by a gust of wind but the passenger was thrown clear of the machine, escaping serious injury.

The River Steamer "Sirus" struck a shoal in the St. Lawrence River, Aug. 1, eight miles below Massena, N. Y. The steamer capsized and the 75 passengers were thrown into the water. Seven persons were drowned.

A Guy Derrick Fell July 27 at Websterville, Vt., in the McIver & Mathieson quarry. Two men were killed. The accident occurred while a heavy rock was being raised and is ascribed in press reports to the "loosening" of one of the steel guy ropes.

A Flour Mill Explosion July 28 at Winona, Minn., in the mill of the Bay State Milling Co., caused a fire which completely destroyed the plant. The fire started in the sacking room on the main floor and is ascribed to an explosion of flour dust ignited by sparks from an electric motor.

A Cave-In on a Tunnel under construction on the Knoxville division of the Louisville & Nashville R. R., between Covington and Latonia, on July 24, caused the death of one workman and the serious injury of four others. A new tunnel of larger section is being built on the line of an old ½-mile tunnel, enough room being left between the old arch and the new for the erection of falsework and the passage of muck cars. The new work had progressed to within 80 ft. of one end, and it was the arch of this short section of the old tunnel that collapsed.

A Chicago Harbor Project which provides for lake-front harbor facilities extending from the mouth of the river north to Chicago Ave. and south to 29th St. has been approved by Mayor Harrison. Under the proposed plans, the piers north of the river would be for passenger and general freight steamers, while those between 12th and 29th Sts. would be for the freight steamers of the railway lines. Between the river and 12th St., including the water front of Grant Park, would be piers for yachts and excursion steamers, while some of these piers would be built as recreation piers for the use of the public. An outer breakwater would be required, extending from the present government breakwater north to North Ave. and south to 39th St. The federal government would be asked to build this. The water front utilized under this plan would be about four miles in length, and on this there would be 25 miles of pier front. Railway connections for the freight piers are included, and driveways and street car connections for the convenience of the public. North of the river there would be a main extending from the shore, and on its south side would be three piers approximately parallel with the shore, separated by slips about 200 x 500 ft. The south system would include nine freight piers about 2,500 ft. long and 500 ft. wide, separated by slips 300 ft. wide. These would be at an angle of about 40° with the shore line. The project is a combination of several individual projects which have been suggested by various parties.

New Subway Construction Was Started in New York City on July 31 at 67th St. and Lexington Ave., with a silver-spade ceremony conducted by W. R. Wilcox, Chairman of the Public Service Commission. It follows the decision of the Board of Estimate to approve of the Commission's executing contracts for the Lexington Ave. Subway (Triborough route), bids on the construction of which were received Oct. 27, 1910 (see Eng. News, Construction News pages, Nov. 3, 1910). The contracts executed to date are for: Section 5, 14th St. to 27th St. along Irving Place, Gramercy Park and Lexington Ave., Metropolitan Contracting Co.; Section 6, 27th St. to 40th St., along Lexington Ave., Bradley Contracting Co.; Section 7, 40th St. to 53rd St., along Lexington Ave., C. H. Peckworth; Section 8, 53rd St. to 67th St., along Lexington Ave., Bradley Contracting Co.; Sections 10 and 11, 79th St. to 93rd St. and 93rd St. to 106th St., along Lexington Ave., Bradley Contracting Co.; Section 12, 106th St. to 118th St., along Lexington Ave., Oscar Daniels Co.

The original bids were on a plan calling for a

wider and higher cross-section than that of the existing subway, but it has since been decided to reduce the size to the older standard. The unit-prices named in the bids will apply, but the estimated totals will be considerably reduced.

This work follows after nearly a year of dickering betwen the city's Board of Estimate, the Interborough Rapid Transit Co., and the Brooklyn Rapid Transit Co., for an operating and construction agreement which would require the minimum amount of city money and afford the most favorable terms during the term of the operation contract. The original invitation for bids for construction and operation, asked by the Public Service Commission for Oct. 20, 1910, brought no offer, but after the construction bids of Oct. 27 were received the above-mentioned negotiations began, chiefly because Mayor Gaynor at all times was strongly in favor of throwing the new lines to the Interborough company in order that only a single subway system should exist. The final conclusion, as noted in our last issue (p. 127) was against the Interborough and in favor of the Brooklyn Rapid Transit Co., but no binding agreement has been made and none can be made for a long time to come. The present status of the subject is practically the same as if construction had been started early last November, except that the cross-section has been reduced.

A Novel Railway-Rate Decision was rendered by the Interstate Commerce Commission during the past week, although the opinion and order as published are dated June 21, 1911. It concerns commutation rates between New York City and surrounding suburban points. The railways handling this commutation business combined in May, 1910, to raise all their commutation rates, by amounts varying from 5% to 20% or more. Complaint against these rate increases was made to the Interstate Commerce Commission, and this body, by virtue of the rate-suspending powers conferred upon it by Act of Congress June 18, 1910, suspended the new rates for a month and thereafter started an investigation of the subject. The most important feature of the decision is the conclusion that the Commission has power to control commutation rates as to their reasonableness, although the Interstate Commerce Act provides

That nothing in this act shall prevent * * * the issuance of mileage, excursion or commutation passenger tickets.

Prior to 1889 the Act as passed in 1887 used the words "shall apply to" in place of the above words "shall prevent." Whatever the purport of the original clause, the Commission holds that under the amended clause it has the right to control commutation rates as to reasonableness. The opinion of Commissioner Harlan demolishes the contention advanced by the railways that, so long as commutation rates are less than regular one-way rates, and so long as the latter are conceded to be reasonable, no claim could be made that the former are unreasonable. On the further matter of determining the reasonableness of the new rates, the method and results of the commission's investigation are not particularly useful. The rates of the several roads are compared, and the rates of one of them, against which no special complaint had been entered, are set up as a standard of what is to be considered reasonable. These rates (Central R. R. of New Jersey) are also found to be closely the same as those of the Chicago & Northwestern Ry. at Chicago, which confirms the commission in using them as standard. Then, by comparing with these the rates of the other railways for corresponding distances, the commission declares that where the divergence is large the rate is unreasonable. Most of the commutation rates of the Pennsylvania R. R. are in this way declared to be excessive, and an order is issued requiring their reduction. The Lehigh Valley rates are found reasonable; some of the Erie, Lackawanna, and West Shore rates are declared to be too high, but their adjustment is left to the railways without formal order. In the matter of the New Haven rates action is deferred, pending the investigation of New York Central and New Haven rates by the Public Service Commission of New York State.

The decision of the commission thus does not touch the question of relative cost and yield of suburban service, or justifiability of the rate-increases on the score of increased cost of service. The rates set up as standards are worth recording here:

MONTHLY COMMUTATION RATES DECLARED REASONABLE.

Miles.	10	15	20	25	30	35	40
C.R.R. of N. J. (at New York)	$5.95	$6.25	$7.50	$8.15	$8.60	$9.35	$10.35
C & N. W.... (at Chicago)	5.60	6.30	6.65	7.50	8.40	9.70	10.40

Personals.

Mr. John M. Tücker, Chairman of the State Roads Commission of Maryland, has announced that he will resign about Sept. 1.

Mr. A. E. Loder, until recently Chief Engineer of the Los Angeles County Highway Commission, will open an office in Los Angeles, Cal., for the general practice of engineering.

Mr. Charles A. Newhall has resigned as Chemical Engineer of the Superior Portland Co., of Baker, Wash., and has opened an office and laboratories at 603 Northern Bank & Trust Bldg., Seattle, Wash., as a consulting engineer.

Mr. George L. Watson has resigned as Chief Engineer of the United Paving Co., and as Engineer and Superintendent for Lockwood & Cherry, Contractors, of Atlantic City, N. J., and will open an office in the Land Title Bldg., Philadelphia, Pa., as a consulting engineer.

Mr. E. G. Kastenhuber, Assoc. M. Am. Soc. C. E., for the past two years acting Resident Engineer of the Bordentown, N. J., sewage disposal works, has resigned to become Assistant Engineer with Mr. Clyde Potts, M. Am. Soc. C. E., Consulting Sanitary Engineer, of 30 Church St., New York City.

Mr. R. B. Stearns, for several years General Manager of the Chicago & Milwaukee Electric Railway Co., has been appointed Assistant General Manager of the Milwaukee Electric Railway & Light Co. and subsidiary companies. Mr. Stearns is a graduate of Purdue University and was at one time Chief Engineer of the Northwestern Elevated R. R. of Chicago, Ill.

Mr. S. B. Clement, Assoc. M. Can. Soc. C. E., Chief Engineer of the Temiskaming & Northern Ontario Ry., has been given jurisdiction over engineering, maintenance of way and motive power departments, succeeding to a part of the duties previously performed by the Superintendent, Mr. J. H. Black, who has resigned to accept a position with the Northern Ontario Light & Power Co.

Messrs. Joseph Ripley and Mortimer G. Barnes, M's. Am. Soc. C. E., members of the Advisory Board of Consulting Engineers of the New York State Barge Canal, which was abolished by recent action of the state legislature, have been appointed, subject to the approval of the Governor, by State Engineer Bensel, as consulting engineers on the Barge Canal work in accordance with the Act of the Legislature, noted in our issue of July 20, 1911, p. 97. Mr. Ripley is retained at his previous salary of $7,500 per annum, and Mr. Barnes is to receive $60 a day when actually employed. Mr. Bensel further announces that he will appoint Prof. William H. Burr, M. Am. Soc. C. E., of Columbia University, and Mr. George G. Green, former Chief Engineer of the New York City Department of Docks, as consulting engineers, also.

Obituary.

Peter A. Dey, the first Chief Engineer of the Union Pacific R. R., died in Iowa City, Iowa, on July 11, at the age of 86 years. A biographical sketch of Mr. Dey will appear in a later issue.

Joseph F. Tucker, Chairman of the Central Freight Association, and one of the oldest railway officials of the country, died on July 26 in Chicago, Ill. He was born in Saco, Me., on Sept. 29, 1835, and entered the railway service in 1856 with the Illinois Central R. R. He rose rapidly in the operating department and became General Superintendent and later General Traffic Manager. From 1885 to 1890 he was Assistant General Manager of the Chicago, Milwaukee & St. Paul Ry., and from 1892 to 1893 he was Vice-President and General Manager of the Chicago, Ft. Madison & Des Moines Ry. The following year he was appointed Commissioner of the Chicago & Ohio River Traffic Association and since 1906 he had been Chairman of the Central Freight Association.

Francis D. Casanave, former General Superintendent of Motive Power of the Baltimore & Ohio R. R., died recently at Escot, France. He was born in France in 1843. His railway experience began with the Pennsylvania R. R. as an apprentice in the Altoona shops in 1862. After a thorough training in the shops he was transferred to the drafting room, where he remained until 1875, when he was sent to the Baldwin Locomotive Works as an inspector for the Pennsylvania R. R. The following year he was made Assistant Master Mechanic of the Altoona shops. In 1881 he was appointed Master Mechanic of the shops at Fort Wayne, Ind., and six years later was promoted to General Superintendent of Motive Power of the Pennsylvania Lines West of Pittsburg. In 1893, he was promoted to the same position for the Lines East of Pittsburg, which position he resigned in 1901 to become General Superintendent of Motive Power for the Baltimore & Ohio R. R. In 1903 he returned to the Pennsylvania R. R. to take charge of the exhibit of that company at the Louisiana Purchase Exposition at St. Louis, Mo., as Special Agent.

James C. Brooks, President of the Southwark Foundry & Machine Co., of Philadelphia, Pa., died on July 18. He served throughout the Civil War and retired from the army with the rank of major. After the war he was engaged for some years in mercantile pursuits, but eventually became associated with the firm of Wm. Sellers & Co., of which firm he became a partner. Here he established a wide reputation both in business and engineering, and in 1887 he was asked to accept the position of President of the Southwark Foundry & Machine Co., when the affairs of that company were in a very critical state. The late Charles T. Porter in his "Engineering Reminiscences" states that at this time "the company had no money to carry on the business, and no business worth mentioning to carry on, and they owed a floating debt of $175,000." Mr Brooks proposed to the directors that, "if they would raise $250,000 by an issue of preferred stock, to pay off the floating debt and give him $75,000 to start with, he would take hold and see what he could do. This proposition was accepted and Mr. Brooks took hold; and by a rare combination of engineering skill and business ability and force of character, having no one to interfere with him, he soon set the business on its feet, and started it on a career of magnificent development." Mr. Brooks was prominent in the business and financial circles of Philadelphia and a director of several banks and corporations.

Engineering Societies.

COMING MEETINGS.

SOUTH DAKOTA ENGINEERING SOCIETY.
Aug. 23-26. Annual meeting at Deadwood, S. Dak. Secy., R. G. Culbertson, Mitchell, S. Dak.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 29-Sept. 1. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Tex.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12-15. Annual convention at Atlantic City, N. J. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 13-15. Annual convention at Glenwood Springs, Colo. Secy., F. D. Morris, P. O. Box 1052, Colorado Springs, Colo.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-29. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

International Municipal Congress.

This congress will meet at Chicago, Ill., Sept. 18-30. It will be attended by delegates from important cities in America and Europe. Papers will be presented on subjects involved in municipal government and undertakings. An exposition of municipal supplies and equipment will be held in connection with the congress. The secretary is Mr. Curt. M. Treat, 1107 Great Northern Bldg., Chicago, Ill.

American Institute of Mining Engineers.

A committee has been appointed to meet with a committee of the Mining and Metallurgical Society to discuss the feasibility of uniting the two organizations into one national society.

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